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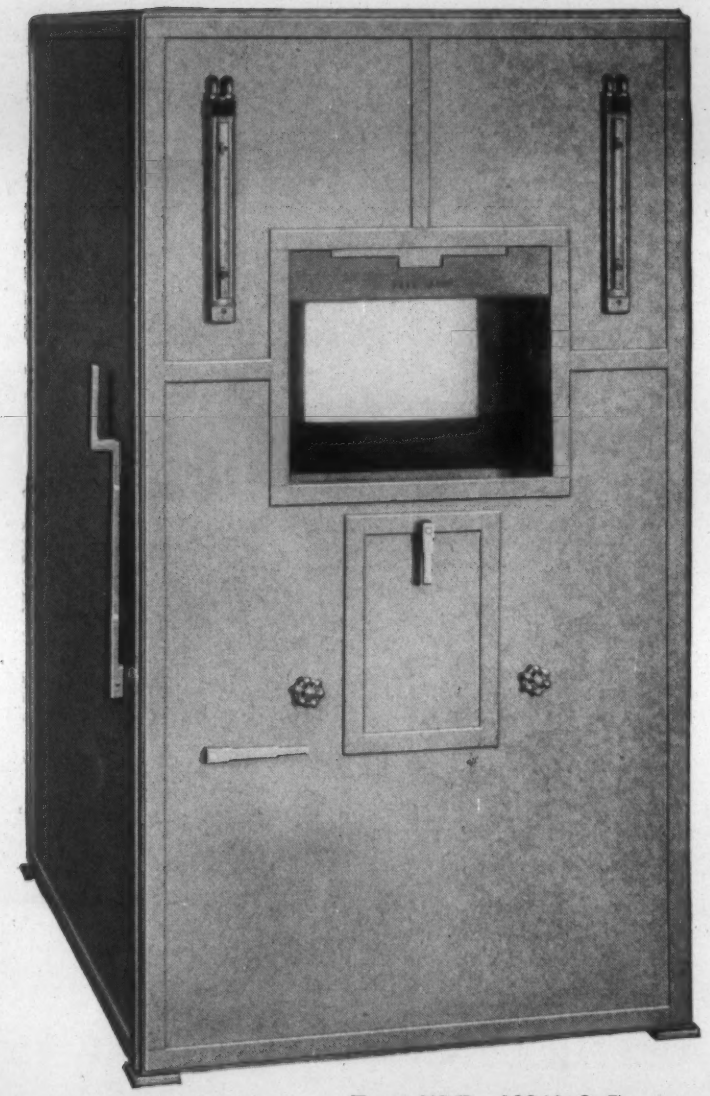

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HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

Russians Sorting Iron Ores

Careful sorting of iron ores to insure a uniform furnace feed has been practiced for years in the United States. The Russians are now finding this profitable (page MA 137 L 4).—J.A.

Reducing Zinc Ores With Natural Gas

The Bureau of Mines has carried its studies of the natural gas reduction of zinc ores to the point where the next step is the erection of a pilot plant. No further work on the problem is contemplated by the Bureau. The results summarized in R. I. 3256 (page MA 137 L 6) show the feasibility of 95 per cent extraction with 5 cu. ft. of gas producing 1 lb. of metal. Retort capacity is about 300 lbs. of Zn per day.—A. H. E.

Germans Favoring Charcoal Pig

Beloni (page MA 137 R 9) remarks that Germany is going in heavily for charcoal pig iron.—H. W. G.

Be Sure Acetylene is Sulphur-Free

Due to the fact that fused nickel exhibits a great capacity for gases which tend to embrittle and weaken the metal Hermann (page MA 150 L 5) states in the *Metallurgist* that it is important that sulphur-free acetylene be used and that a lightly reducing flame be employed.—C.A.McC.

Bronze Welding

By bronze welding, high melting point alloys can be joined without fusion of the base metals. Kinzel and Lytel (page MA 150 L 8) emphasize the need for careful supervision in manufacture as well as close chemical control.—C. A. McC.

Rapid Progress in Electroplating of Tin

Slowly but surely tin electroplating is forging ahead. The results of an investigation recently completed at Woolwich Arsenal, London (page MA 156 L 5) serve to clarify the situation whereby dense non-porous coatings of tin can be produced by electrodeposition.—H.S.R.

Sheep Offer a Cue to the Corrosion Problem

The lowly sheep gives the metallurgist the proper cue for the protection of metals from corrosion (page MA 157 L 5). An investigation of 5 years' duration at the National Physical Laboratory just completed shows that lanolin, a product made from wool-fat, is the best coating for the protection of metals in storage. Pure lanolin is not necessary, partially refined lanolin is entirely satisfactory.—H.S.R.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

What is a Good Test for Welds?

Elongation, impact resistance and bend test values are better than tensile tests for showing up porosity in welds (page MA 159 L 2). Radiographs, when used with caution, can also be useful (page MA 159 L 4).—C.S.B.

Micro-Cracks, Shatter Cracks and Flakes

Scheil, German internal stress expert, hands down a decision on the relation of micro-cracks to internal stresses, shatter cracks and flakes (page MA 159 L 5).—C.S.B.

'Tis Well to Review Old Rules Anew

The observed strength properties of metals are little affected by the size and shape of the test piece (page MA 160 L 7) while elongation and reduction of area are affected appreciably.—W.A.T.

Precipitation Hardening

Auer and Gerlach (page MA 163 R 2) report interesting changes of magnetic susceptibility upon aging of quenched 5 per cent Cu-Al alloy. This may mean a tool which will untie Merica's knots—and other things.—J.S.M.

Large (and How!) Forgings Studied

Maurer and Gummert (page MA 165 R 3) compare the properties of carbon and several low-alloy steels as forged from 45-ton and 100-ton ingots. Among other things, they state that mechanical properties are but little affected by original ingot size, in spite of the fact that grain size was finer in the smaller ingot.—E.S.D.

Hardenability of Vanadium Steels

Houdremont and associates (page MA 165 R 5) give us the lowdown on the hardening characteristics of these valuable and interesting steels with particular reference to the behavior of the carbides and their influence on hardenability.—E.S.D.

Cr-Mo Steels for Boilers

Two reports from Germany (page MA 166 L 2 and L 3) agree in recommending Cr-Mo steels as excellent boiler steels, and Lachmeier states that 0.25 per cent Cu improves high temperature properties of steel.—L.J.

"Statistics" Applied to Corrosion

We have heard much recently of the "Law of Possibilities" and we have probably understood less. However, we have now reached the point, according to Dr. G. N. Scott of the National Bureau of Standards (page MA 166 L 9) where we can use this mathematical tool to solve our pipe line corrosion problems. By simply recording the condition of each piece of pipe removed from the ground, particularly the depth of the maximum pit, which can be very easily and inexpensively done, and reporting these data to a central agency, in the course of a comparatively short time we will have sufficient data to clarify the factors determining pipe line economy.—V.V.K.

Soil Corrosion and Protective Coatings

The very valuable and comprehensive work of the National Bureau of Standards on soil corrosion and its prevention by protective coatings has been ably reviewed by K. H. Logan (page MA 166 R 9). The progress made up to the present time and the data, yet to be obtained, necessary for the solution of this problem is outlined. Here is a problem, whose importance is incontestable, the solution of which is within our grasp provided the National Bureau of Standards receives a continuance of cooperation from industrial corporations.—V.V.K.

Corrosion of Lead by Water

Ingleson (page MA 167 L 1) presents a "correlated abstract" of 115 pages on corrosion of lead by water.—H.W.G.

Pouring Temperature and Softness of Zinc Castings

Zinc castings are softer when poured from a low temperature than when poured from a high temperature, according to Burkhardt and Sachs (page MA 167 L 4).—H.W.G.

Portable Steel Roads

Interlocking metal channels of pressed steel have been utilized in a new military road construction which might be adapted to civilian construction projects according to an article in "Engineer" (page MA 168 R 2).—M.G.

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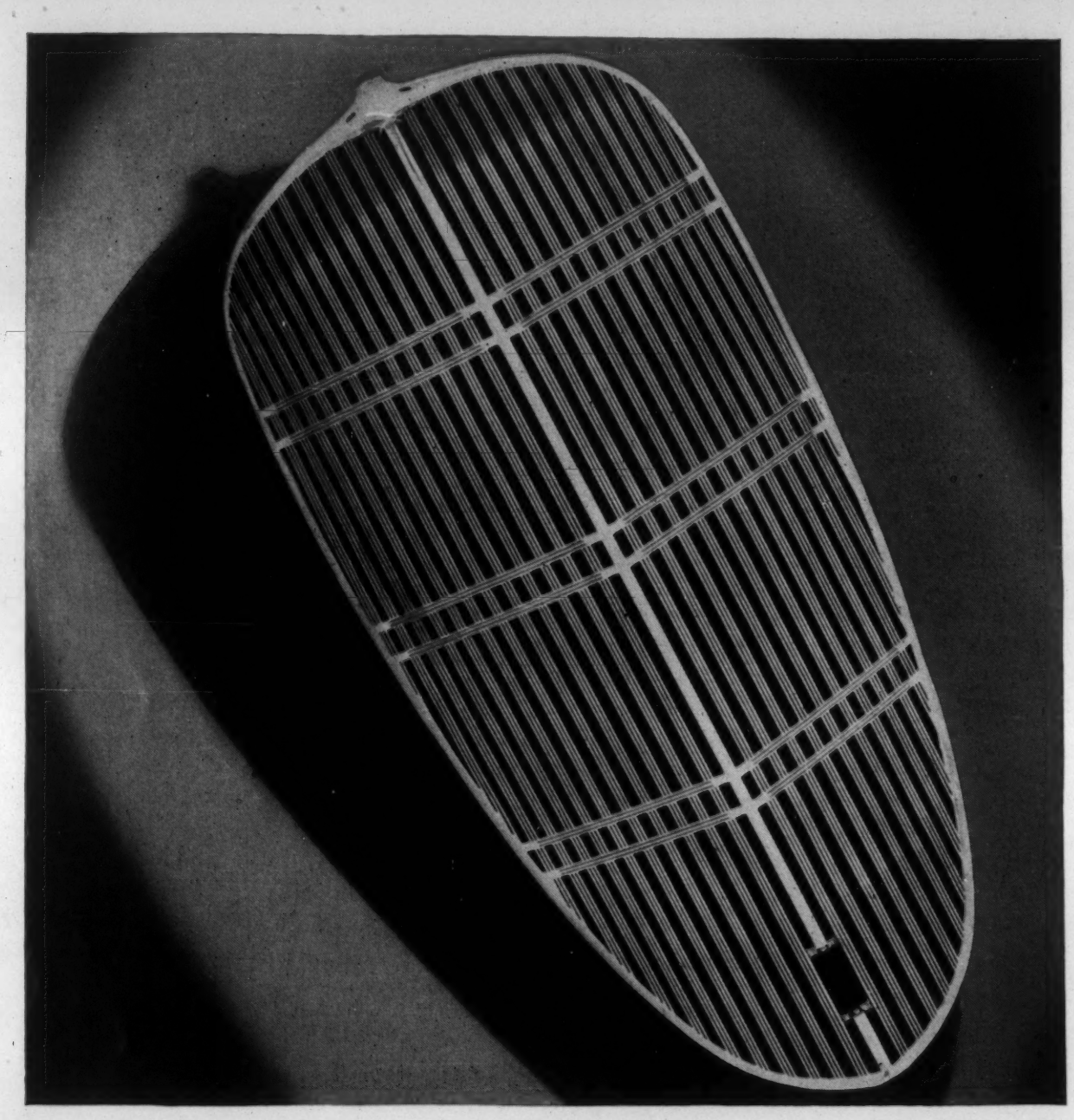

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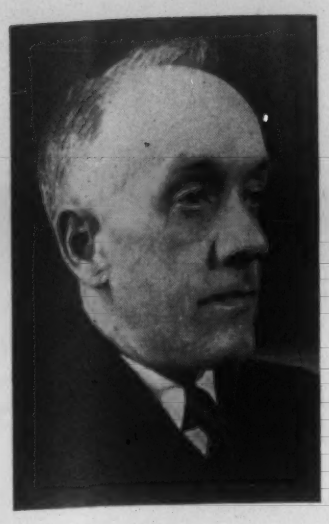

Editorial Comment

Corrosion and Painting

GREAT MASSES OF DATA on weather exposure of steel have been accumulated by the A. S. T. M., and by various steel makers. The completed experiments have conclusively shown the benefit of copper as an alloy in steel to reduce the corrosion of the bare steel.

The corrosion angle enters into the evaluation of the new low-alloy high-yield steels that are springing up in such profusion here and abroad, and which are being pushed for use in light-weight freight cars, in bridges and for general outdoor use, and this accounts for the almost universal presence of copper.

In such uses bare steel is seldom, if ever, used. Even though the alloy steel chosen may have a measurable longer life than plain carbon steel, nobody wants to lose the period of protection given by paint or other coatings. Fences will be galvanized, even though the base steel is one that will not rust away too rapidly after the zinc has been weathered through. The effort is to get the additive life due to the properties of the steel plus that due to the protective coating. While farm fences are never recoated, nor are many galvanized roofs on farm buildings, on the other hand, industrial structures, whether buildings, freight cars or what not, are normally expected to be repainted. The corrosion-resistant properties of the steel are chiefly utilized as insurance that too great deterioration will not occur between paintings.

If an engineering point of view be adopted as to total life of the structure on the basis of first cost and upkeep cost, then the ability of a given steel to take a paint coat and hold it in such condition that it really does protect for a longer period than another steel, would be counted as positive a virtue as a better corrosion resistance of the bare steel.

The paint people have put out innumerable test specimens and test racks for weather tests, they have developed accelerated weathering tests that some consider useful, and a good many of them are utilizing an exposure testing station in Florida where failure may come more rapidly than in some other locations. But when the paint man plans to study the life of a paint, he usually spreads it on wood, often on three kinds of wood, for he knows that different woods behave differently. He also knows that the priming coat is of extreme importance. Similarly, the surface finish of a metal is a variable comparable to the "grain" of wood, and the adhesion of the primary coat is of great importance.

Relatively little attention seems to be paid to paints on metal, or if the subject is dealt with, it is usually handled without much cooperation with the metallurgist. Bureau of Standards Letter Circular 422 is written primarily from the paint viewpoint. A. S. T. M. exposure tests on galvanized steel and on various othe metallic coatings are under way, but we know of no comprehensive study of paints-for-metals and metals-for-painting in which the best efforts of the paint-maker to produce a superior paint to go on a metal and of the metallurgist to produce a superior metal to take this paint are being combined. It would seem that the A. S. T. M. metal men and paint men might well sit more closely together for the study of their joint problems and the standardization of test methods that might be used to evaluate both the paints and the metals in the same series of exposure tests.

The matter has been given some thought by the railroads, but we doubt if they could evaluate a new low alloy steel from the point of view of its ability to hold an impervious paint film, or to behave well beneath a pervious one, without actually trying out each steel. Every maker of a high-strength low-alloy steel has to attempt to evaluate its weather resistance in comparison with plain steel and copper-bearing steel, but these guesses as to life are almost invariably made on the basis of expected performance of bare steel.

In England some corrosion investigators, such as Evans, Hedges, and others have paid attention to the way the presence of a paint film affects the processes of corrosion, and the Corrosion Committee of the Iron and Steel Institute and cooperating organizations is including in its exposure tests, specimens of a few different steels, with surfaces prepared in different ways, and painted with a couple of different paints. Those data will be a lot better than nothing but will not carry the subject very far.

It seems to us that the metallurgist is overlooking the possibility of developing steels which will have, or can be given surfaces upon which properly selected paints will have a longer life than is obtained in present practice. If a salesman could say, and could substantiate his statement, "Our steel not only is as corrosion-resistant when bare, as the competing steel of similar mechanical properties, but it will hold a paint twice as long," it ought to affect the purchaser's choice.

Investigations along this line would be long drawn out and would be very complex because of the vast number of variables that would have to be considered. But they might turn out very much worth while.—H. W. Gillett.

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Wrought Copper-Nickel-Aluminum Alloys

By D. K. CRAMPTON* and H. P. CROFT†

THE ALLOYS OF COPPER, nickel, and aluminum, containing nickel equal to or in excess of aluminum, have been fairly well investigated and reported in the literature. The first extensive work was published by Read and Greaves[1], who investigated rather thoroughly three series of alloys containing 1, 5, and 10 per cent aluminum, respectively, with nickel varying from about 1 to 15 per cent in each series. A wide range of properties was determined for various physical conditions.

Early Work in This Field

They noted that nickel whitened the typical golden yellow color of the copper-aluminum alloys but this latter could not be completely destroyed even with nickel up to 15 per cent. Alloys of all aluminum contents and containing up to 10 per cent of nickel hot worked nicely. The alloys exhibiting good cold rolling properties were those containing up to 5 per cent aluminum and up to 5 per cent nickel. Increasing the nickel to 10 per cent considerably lessened the capacity for cold rolling. Experiments on drawing of wires proved that all alloys containing 5 per cent aluminum and up to about 7.5 per cent nickel worked quite satisfactorily. It was found practically impossible to draw wires containing 10 per cent aluminum and over about 5 per cent of nickel.

As would be expected, an increase of nickel and of aluminum considerably improved the maximum strength and yield point and correspondingly reduced the contraction of area and elongation. Tests on conductivity showed the very powerful effect of both aluminum and nickel, the alloy with 5 per cent of each, for instance, showing a conductivity of only 10 per cent of that of copper. All the alloys investigated showed relatively good corrosion resistance. In general, the 5 and 10 per cent aluminum alloys were about equal and appreciably better than the 1 per cent aluminum alloys. With 10 per cent of nickel the alloys of all aluminum contents were about equal and exhibited very low losses.

Read and Greaves at this time made no observations on precipitation hardening as such, but did observe that certain alloys were markedly harder and stronger when slowly cooled than when in the quenched condition. In a second paper[2] the same authors treated the precipitation hardening characteristics at considerable length. Fig. 1, reproduced from their work, gives the first indication of the capacity of these alloys for precipitation hardening. In this diagram Brinell hardness values for the individual alloys studied are shown. The upper figure is the hardness of the slowly cooled alloy and the lower figure the same for the alloy quenched from 900 deg. C.

In this diagram the line AB indicates the approximate limit of the alpha solution at 900 deg. C. It is seen that the solubility of aluminum at this temperature is practically unaffected by increasing the nickel up to 8 per cent, the highest amount investigated. On the other hand, the line CDE indicates the solubility limit at atmospheric temperature. Alloys to the left of the line AD and below the line CD are entirely alpha

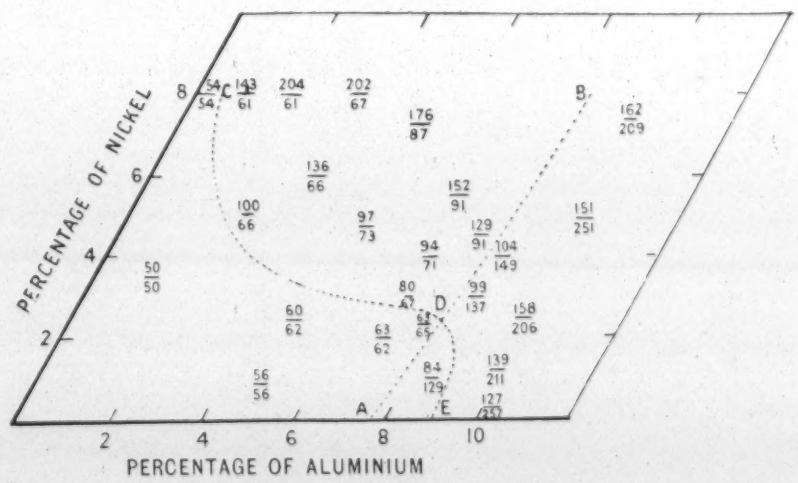

Fig. 1—Brinell Hardness of Quenched and Slowly Cooled Alloys. (From work of Read and Greaves.)

at all temperatures, and quenching produces no difference in hardening or other properties. Alloys to the left of BD and above the line CD are much more soluble at high temperatures than at low temperatures. This condition is a prerequisite for precipitation hardening. The authors' hardness tests indicate a very considerable hardening does in fact take place. Alloys to the right of the line AB show the typical increase of hardness on quenching as compared to slow cooling which is found in straight copper-aluminum alloys.

Fig. 2 is reproduced from the same work and shows the effect of the precipitation anneal on Brinell hardness of five different alloys. The highest ratio of nickel to aluminum used in this series was 1.4 to 1. This was insufficient to bring out the maximum hardening capacity.

In another series of tests they investigated the effect of time and temperature on reheating on the same alloys and found the optimum reheating conditions

* Research Director, Chase Brass & Copper Co., Waterbury, Conn.
† Metallurgist, Chase Brass & Copper Co., Cleveland, Ohio.

were approximately ½ hr. at 700 deg. C. They also showed that precipitation treatment markedly improved not only the tensile properties but the endurance limit. In addition to experiments on hardness, they showed the effect of quenching and aging on structure and described the precipitation of a hard constituent, the exact analysis of which they did not

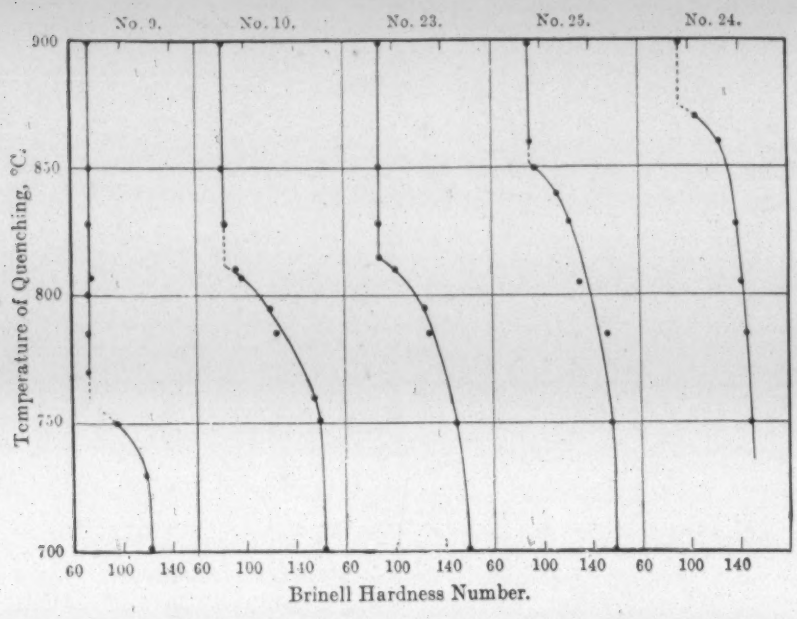

Fig. 2—Aging Characteristics of Some Copper-Nickel-Aluminum Alloys. (From work of Read and Greaves.)

attempt to give. Photomicrographs were given showing this precipitate.

Jones, Pfeil and Griffiths[3] investigated alloys with 10, 20, 30 and 45 per cent nickel with aluminum contents up to 4 per cent. Working with both cast and cold worked materials they found the optimum quenching temperature to be about 900 deg. C. and the optimum aging temperature from 500 to 700 deg. C., depending on the exact analysis. They also found an approximate relationship between nickel and aluminum contents for optimum hardening capacity as follows:

Nickel, Per Cent	Optimum Aluminum, Per Cent
10.0	2.0
20.0	3.5
30.0	3.0+
45.0	4.0+

It should be noted that in the alloys of higher nickel content the hardness increment was still increasing with the highest amounts of aluminum used.

An extensive paper by Brownsdon, Cook and Miller[4] appeared simultaneously with that of Jones, Pfeil and Griffiths. They found that for appreciable precipitation hardening, the nickel should be in excess of 2 per cent and the aluminum in excess of 0.5 per cent. They reported the optimum hardening effect occurred with the nickel content at least four times the aluminum content.

Extensive tests showed that practically complete softening followed quenching from 800 to 1000 deg. C., depending upon exact analysis with the optimum at possibly 900 deg. C. This checks exactly with that reported by Jones, Pfeil and Griffiths. The best range of temperature for precipitation was from 400 to 600 deg. C with the optimum probably at 500 deg. C for most of the alloys. They found that for alloys showing greatest precipitation hardening effects a 2-hr. aging time was sufficient to develop the maximum effect. However, for those alloys exhibiting relatively slight hardening capacity, a distinctly longer time as, for instance, 20 hrs. was much better.

A recently published booklet[5] showed very interesting properties developed by the addition of nickel and aluminum to brasses. These so-called Kunial brasses contain about 70 per cent copper and such proportions of nickel and aluminum as to give a marked precipitation hardening effect. In general, it was shown that the copper-nickel-aluminum-zinc alloys could be treated much the same way as the copper-nickel-aluminum alloys. The optimum hardening temperature was shown to vary considerably with the degree of cold reduction given between the solution and precipitation anneals. The optimum conditions were given as follows:

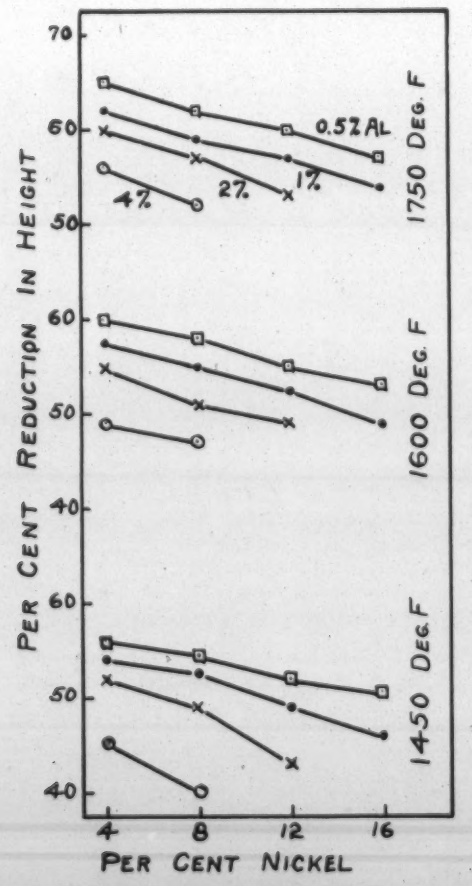

Fig. 3—Forging Properties of Copper-Nickel-Aluminum Alloys.

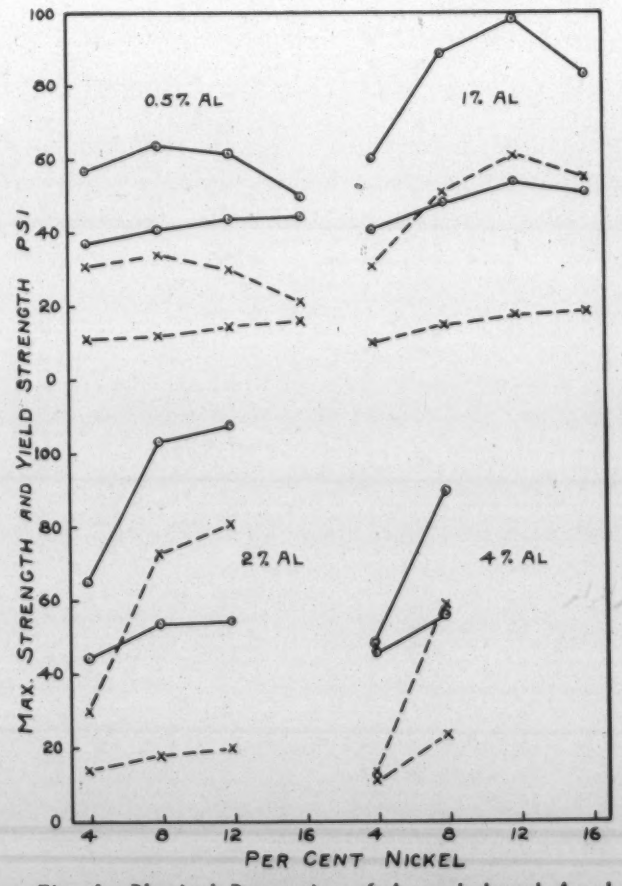

Fig. 4—Physical Properties of Annealed and Aged Copper-Nickel-Aluminum Alloys. Solid lines show maximum strength and broken lines yield strength. The lower curve in each case is for the annealed material and the upper curve for the aged material.

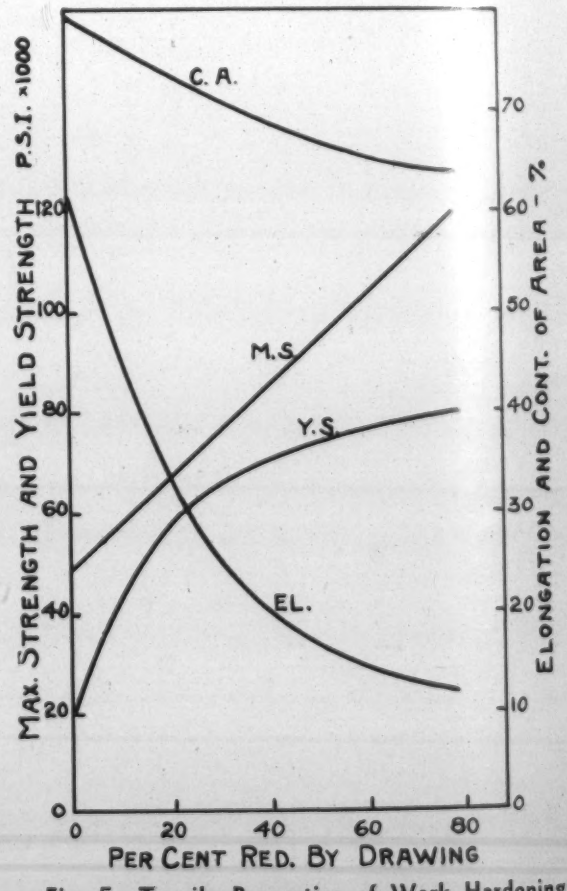

Fig. 5—Tensile Properties of Work Hardening 92-4-4 Copper-Nickel-Aluminum Alloy.

Per Cent Reduction	Optimum Aging Temperature, Deg. C.
0	500
10	450
50	400
80	375

Merica and Mudge[6] recently discussed the heat-treatable alloys produced by the addition of aluminum to Monel metal, and a recent booklet[7] was largely devoted to that type of alloy. Some data were, however, included on aluminum-bearing nickel-silvers. In particular, the physical properties of an alloy containing copper 72.5 per cent, zinc 20 per cent, nickel 6 per cent, and aluminum 1.5 per cent were interesting. Comparison of these results with some reported by Brownsdon, Cook and Miller for an alloy with identical nickel and aluminum but no zinc showed that the zinc in general appreciably increased the strength. As quenched the zinc-bearing alloy showed a much higher elongation but, as rolled and aged, a much lower one.

Recent Investigations

During the last two or three years these alloys have been investigated intensively in our own laboratories. In general, our findings agree nicely with those reported above. Some data are presented herewith supplementing those previously reported.

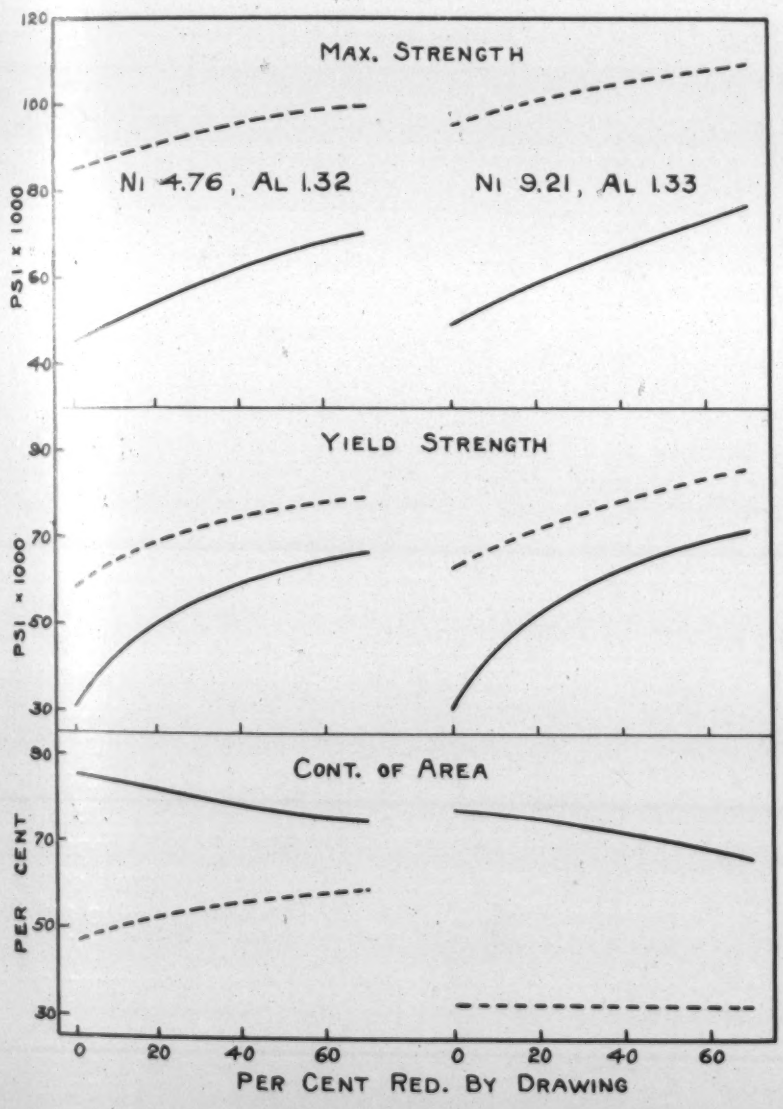

FIG. 6a.—Physical Properties of Two Hardenable Copper-Nickel-Aluminum Alloys. The solid curve in each instance is for the annealed and drawn material and the broken curve in each case for the annealed, drawn and aged material.

The capacity of alloys to be hot worked is of great importance in mill production. Fig. 3 shows results of a series of forging tests on copper-nickel-aluminum alloys containing 4 to 16 per cent nickel and 0.5 to 4 per cent aluminum. These tests were carried out on rod specimens 5/8 in. in diameter, 1 in. long. An ordinary drop hammer adjusted to give a blow of 600 ft. lb. was used. The per cent reduction in height of specimen at three different forging temperatures is given. All of the specimens withstood this operation without fracture so that the values for reduction in height may be taken as true relative indices of ease of forging. A study of the curves shows that for any aluminum content and any forging temperature the

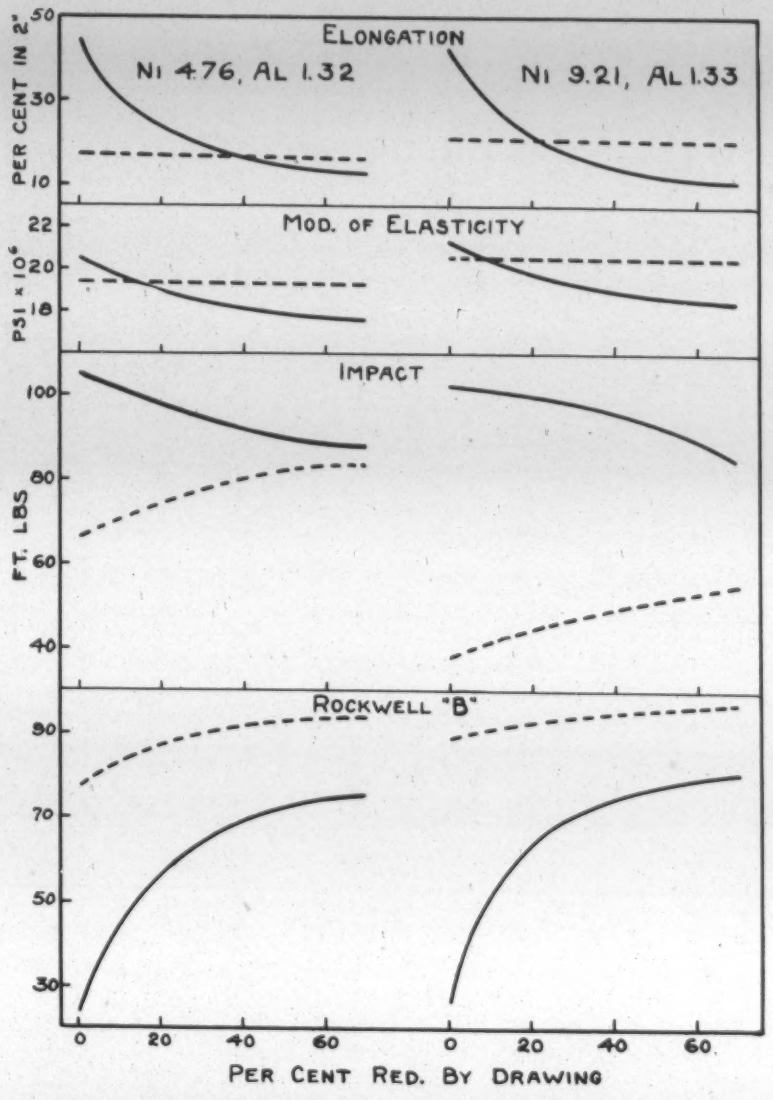

FIG. 6b.—Physical Properties of Two Hardenable Copper-Nickel-Aluminum Alloys. The solid curve in each instance is for the annealed and drawn material and the broken curve in each case for the annealed, drawn and aged material.

ease of forging falls off very appreciably as the nickel content is increased. The effect of aluminum is similar to, but much more marked than, that of nickel at all temperatures used. All the alloys which from other considerations appear logical commercial ones can be nicely forged, indicating the ability to be economically produced.

The effect of precipitation hardening on tensile strength and yield strength (½ per cent elongation under stress) for the same series of alloys is shown in Fig. 4. In the four groups of curves the effect of nickel content, aluminum content and aging treatment is clearly brought out. The results agree quite well with the findings of previous authors. It will be noted that these rods were not drawn either before or after the precipitation treatment so that the maximum properties obtainable are not shown. The effect of this working has been pointed out by others and will be again referred to later on. Note particularly that, in the alloy of 4 per cent nickel and 4 per cent aluminum, no precipitation hardening effect whatever was found. This is because of the short time treatment given. As pointed out elsewhere, a much longer time would produce a considerable hardening in this alloy.

Corrosion and Work-Hardening Properties

Our studies indicate that precipitation hardening characteristics are by no means the only attractive

ones possessed by the copper-nickel-aluminum alloys. In the range where little or no precipitation hardening occurs we find alloys of interesting corrosion resistance and work-hardening characteristics. As a result of the above reported work and other preliminary investigations, the alloy, copper 92, nickel 4, aluminum 4 per cent, is indicated as one of the best in this class. Fig. 5 shows the relationship between tensile properties

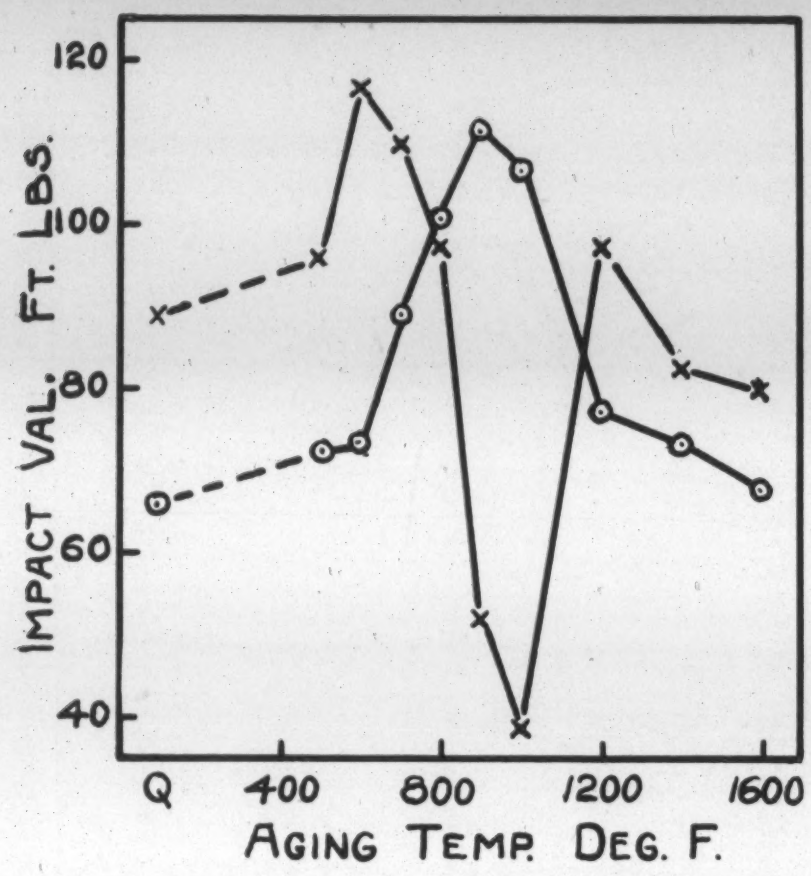

Fig. 7—Effect of Aging on Impact Value of Two Hardenable Copper-Nickel-Aluminum Alloys.
x——x Curve for alloy of Ni 9.21%, Al 1.33%, Cu balance.
o——o Curve for alloy of Ni 4.76%, Al 1.32%, Cu balance.

and reduction by drawing for small diameter rod. The actual analysis was:

	Per Cent
Nickel	3.68
Aluminum	3.87
Copper	Bal.

The material used in these tests was taken from commercially produced, hot-rolled rod 7/8 in. in diameter. This rod was cold drawn to 5/8 in. and annealed soft. A drawing series was then made, starting on 5/8 in. and with an ultimate reduction to 0.258 in., taking off samples at various stages for test. The properties given therefore are for varying sized rods between these limits. This variation in diameter would not affect the strength. It would slightly but not significantly alter the contraction of area and elongation values.

It will be seen that in the soft condition this material has a strength of approximately 48,000 lb. per sq. in., which is increased to 120,000 lb. per sq. in. at 80 per cent total reduction, a perfectly logical one commercially. The yield strength given is that stress at which material shows a total elongation of 0.5 per cent under load. With moderate reductions, it is seen that this approaches the maximum strength. With higher reductions, it still increases although at a less rate than the maximum strength. The elongation values are attractive in comparison with the strengths.

Particular attention is called to the contraction of area curve showing high values, which remain quite high even with extensive cold working. This characteristic is quite generally considered an indication of capacity for further cold work, which in fact is the case in the present instance. One of the decidedly favorable attributes of this alloy from the mill standpoint is its ability to withstand successive and drastic reductions without the need of too frequent intermediate anneals and without exhibiting the least tendency toward a brittle or overdrawn condition.

The resistance of this alloy to corrosion is very high. It has excellent resistance to the impingement type of attack in condenser tubes. Its unusual resistance to sulphur attack is resulting in considerable application as a condenser and heat exchanger tube in the oil refineries. Also alloys of this general type have been used for a considerable time in racks and baskets for steel mill pickle and similar solutions, and have given excellent service. In addition to the above, a considerable number of laboratory tests indicate its suitability for combating various very corrosive liquids. It is premature to report these tests in detail but in general the results obtained to date are excellent. There is an indication that the 92-4-4 type is slightly better for most conditions than the hardenable alloys of higher nickel and lower aluminum contents.

Although this alloy is commonly considered as a work-hardening one and not particularly susceptible to precipitation hardening, it can nevertheless be considerably hardened. Many of these border line alloys, having a relatively low capacity for precipitation hardening, do show considerable such hardening after very long time precipitation treatments.

Figs. 8 and 9 show the structure of the 92-4-4 alloy as quenched and after long time aging. The dark streaked areas in Fig. 9 are due to the precipitation of the nickel-aluminum compound. This is shown in better detail in Fig. 10 at a higher magnification.

Two Readily Hardenable Alloys

Another series of tests on two readily hardenable alloys shows the effect of precipitation hardening on a number of properties. These alloys were of the following compositions:

	No. 1	No. 2
Nickel, per cent...	4.76	9.21
Aluminum, per cent	1.32	1.33
Copper	Balance	Balance
Ratio, Ni to Al....	3.6 to 1	7.0 to 1

In Fig. 6 several properties are plotted as functions of cold reduction for the two alloys as quenched and drawn, and as quenched, drawn and aged. The quenching temperature was 900 deg. C. and the aging treatment was 1 hr. at the optimum temperature indicated by preliminary tests. The various properties obtained both in the quenched and in the aged conditions are interesting. The marked change due to aging is apparent in most of these. The effect of cold drawing between the solution and precipitation anneals is also clearly brought out.

Referring to the curves for tensile test, it is seen that, in both alloys, the increase due to drawing alone is far less than that due to aging alone. Further, if the maximum strength curve of the No. 2 alloy be compared with the corresponding one for the 4 per cent nickel, 4 per cent aluminum alloy in Fig. 5, an interesting fact is brought out. The precipitation hardening alloy has a strength in the quenched condition almost identical with that of the work hardening alloy; namely, 49,000 lb. per sq. in. Cold drawing the precipitation hardening alloy a total of 70 per cent increases the strength to only 77,000 lb. per sq. in., whereas a similar reduction increases the strength of the cold working alloy to 112,000 lb. per sq. in. Even the combined effect of a 70 per cent cold reduction and

the optimum aging treatment brings the strength of the former alloy but to 108,000 lb. per sq. in., not quite equal to that attained by the simple drawing of the latter alloy. The yield strengths (½ per cent elongation under stress) and the Rockwell "B" hardness values, and drawn are typical of those found in ordinary work-hardened alloys. The elongation, fairly high in the annealed state, falls off sharply with initial cold working and then less sharply with increasing degree of reduction. On the contrary, the elongations found

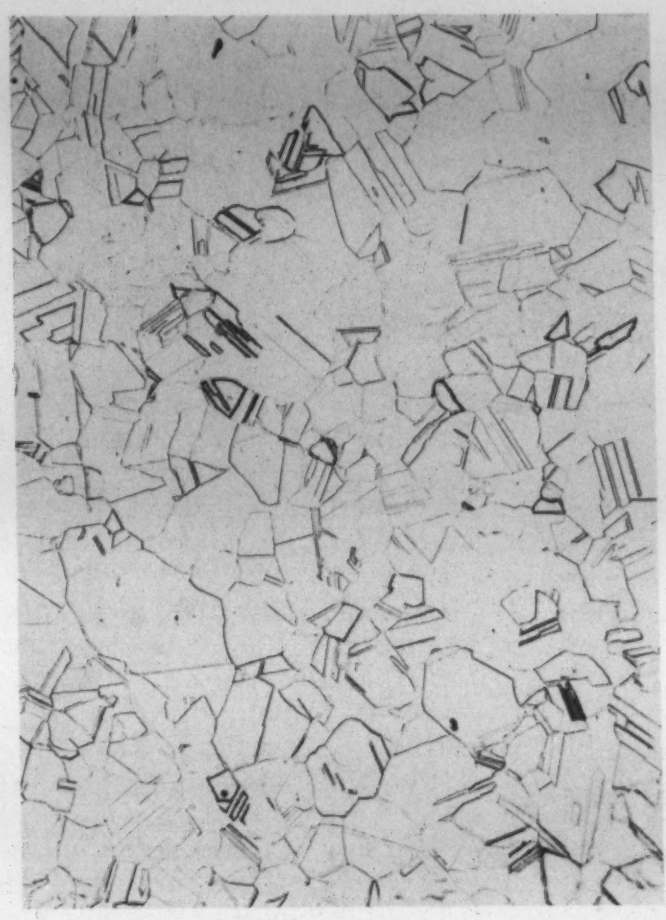

Fig. 8 (Left)—Structure of 92-4-4 Copper-Nickel-Aluminum Alloy, Annealed. Magnification 100 diameters.

Fig. 9—Same Specimen as Fig. 8, But Aged 15 Hours at 1060 deg. F. Magnification 100 diameters.

as would be expected, follow closely the maximum strengths. No particular comment is necessary.

The effect of precipitation hardening on contraction of area is well displayed in Fig. 6. The loss in contraction due to hardening of the lower nickel alloy is considerable, but not serious. However, in the higher nickel alloy, this loss is very material and indicates a very substantial lowering of capacity for further work. Particular attention is called to the fact that after aging the contraction of area is entirely independent of the degree of drawing reduction prior to aging.

The elongation curves in the materials as quenched after precipitation hardening are quite independent of the degree of cold reduction prior to such hardening. Surprisingly also, the elongation of the hardened alloy of higher nickel content is slightly higher than that of the lower nickel alloy.

The effect of aging and drawing treatments on the modulus of elasticity is interesting. In the alloys in the drawn condition the modulus is seen to fall off considerably with increased amounts of cold work. Although this is contrary to the ideas held by many, it is nevertheless quite regular and typical of work hardened alloys. On subsequent aging this effect is

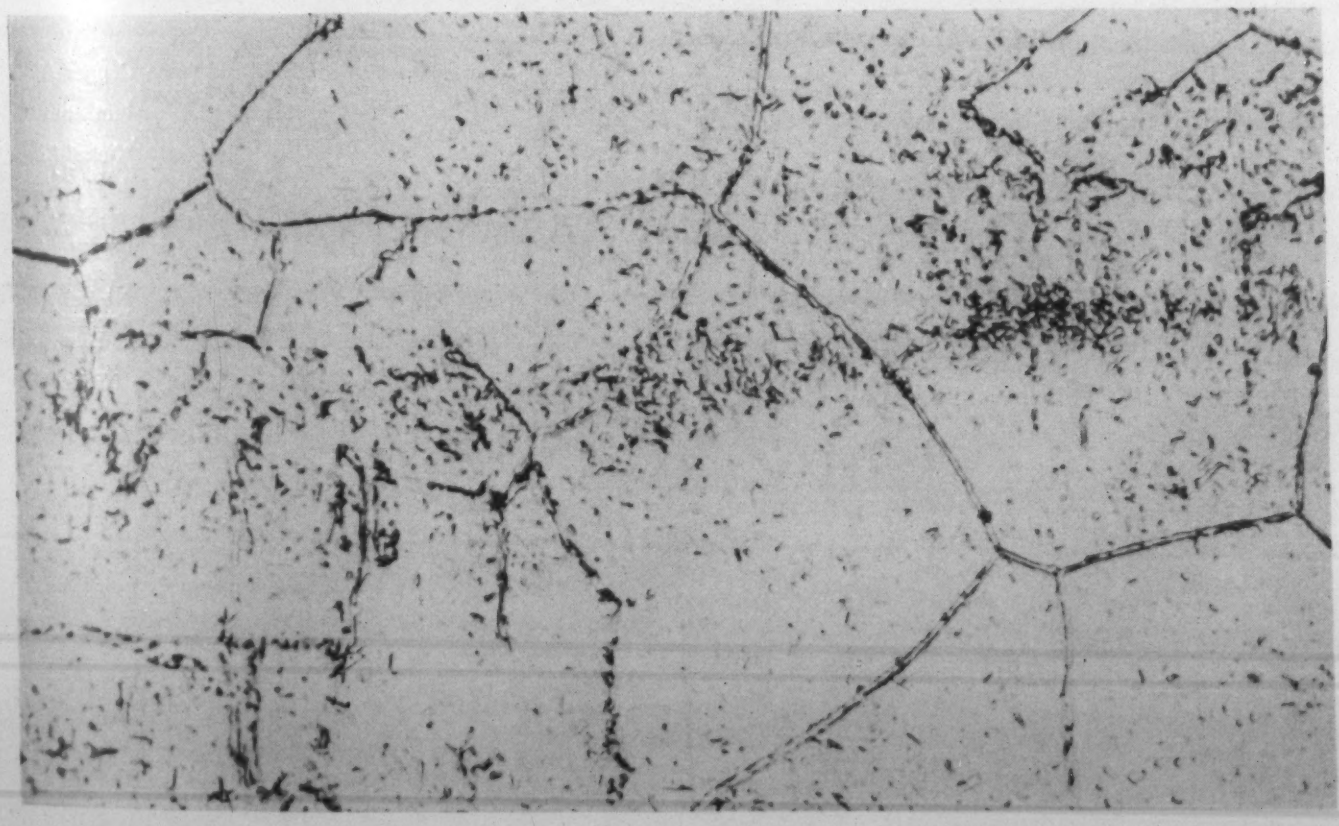

Fig. 10—Same as Fig. 9. Magnification 1000 diameters.

seen to be completely nullified and the moduli of the aged alloys are constant over the entire range of intermediate reduction.

Impact Values Significant

The impact values are very significant. In the drawn condition these are high for both alloys, even after considerable cold reduction. The subsequent aging treatment markedly reduces the toughness of the quenched materials but this effect becomes less and less as the degree of intermediate draw is increased. Surprisingly, the drawn and aged alloys are much tougher than those simply quenched and aged. As an interesting side-light it should be pointed out that the unaged specimens merely bent sufficiently to allow the pendulum to pass and showed no indication of fracture. But in each instance the aged specimens fractured. Probably the values of the former should be considered as somewhat low.

The impact tests of No. 2 alloy showed another feature not indicated by any other test. This is revealed in Fig. 7. The impact value of the No. 1 alloy increases steadily with aging temperature to a maximum

Table of Properties of Typical Work Hardening and Precipitation Hardening Cu-Ni-Al Alloys

	Work Hardening Alloy Cu 92, Ni 4, Al 4	Precipitation Hardening Alloy Cu 91, Ni 7.5, Al 1.5
Melting point, deg. C.....	1090	1120
Density, lb. per cu. in.....	0.302	0.315
Mean coef. of expansion, Ins./in./deg. C.	1.7×10^{-5}	1.7×10^{-5}
Tensile strength, lb. per sq. in.	45,000 to 120,000	48,000 to 110,000
Yield strength, lb. per sq. in...	20,000 to 80,000	30,000 to 80,000
Elongation,* per cent in 2 in.	60—12	50—10
Contraction of area,* per cent	80—50	80—35
Modulus of elasticity, lb. per sq. in.....	$21—18.5 \times 10^6$	$21—18 \times 10^6$
Rockwell "B" hardness*.....	98—15	95—10
Adaptability to hot working..	Excellent	Excellent
Adaptability to gas and arc welding	Good	Good
Adaptability to seam and spot welding	Excellent	Excellent
Adaptability to soldering and brazing	Excellent	Excellent
Corrosion resistance	Excellent	Excellent

* These properties depend considerably on size and shape of test specimen as well as physical condition.

at 900 deg. F. and above that is progressively lowered. In the No. 2 alloy we find this increases to a maximum at 600 deg. F. and then falls sharply to a very low value at 1000 deg. F., the temperature at which all other values were maximum (or minimum). At still higher temperatures it again rises due to annealing. It may therefore be concluded that, in the very strongly precipitation hardening alloys of this system, an intermediate aging temperature might well be used to effect a reasonable compromise between strength and hardness on the one hand and toughness on the other.

Logical Place in Industry

There are many factors to be considered in determining what alloys have a logical place in industry. Obviously, the ease of making clean, sound castings, the relative capacity for both hot and cold working operations and the adaptability to fabrication into numerous finished or semi-finished articles are factors of paramount importance. Also the color, general appearance, ease of cleaning, and many other considerations frequently have some bearing. These are not determined nor even indicated by physical properties ordinarily investigated, such for instance as recorded in the various diagrams in this paper.

As a result of the reported studies of various physical properties and treatments, as well as the relatively less tangible factors above referred to, it is felt that two alloys in this general range, likely to find a considerable commercial application, are a work hardening alloy of approximately 92 per cent copper, 4 per cent aluminum, 4 per cent nickel and a precipitation hardening alloy of perhaps 91 per cent copper, 7.5 per cent nickel, and 1.5 per cent aluminum. A summary of the more important properties of these two alloys is accordingly given in the Table.

The work-hardening alloy is to be preferred from the standpoint of ease of fabrication under normal mill conditions. It also seems to have a slightly superior general corrosion resistance. The age hardening alloy is likely to find its place where considerable machining or intricate cold working is essential and where a finished product is desired of as high strength and hardness as possible. Certainly these alloys have much to commend them to industry and one or the other might well be found suitable for many varied and severe uses. In fact, the 92-4-4 alloy has already gained a fairly wide use for condenser and heat exchanger tubes and for a number of structural uses.

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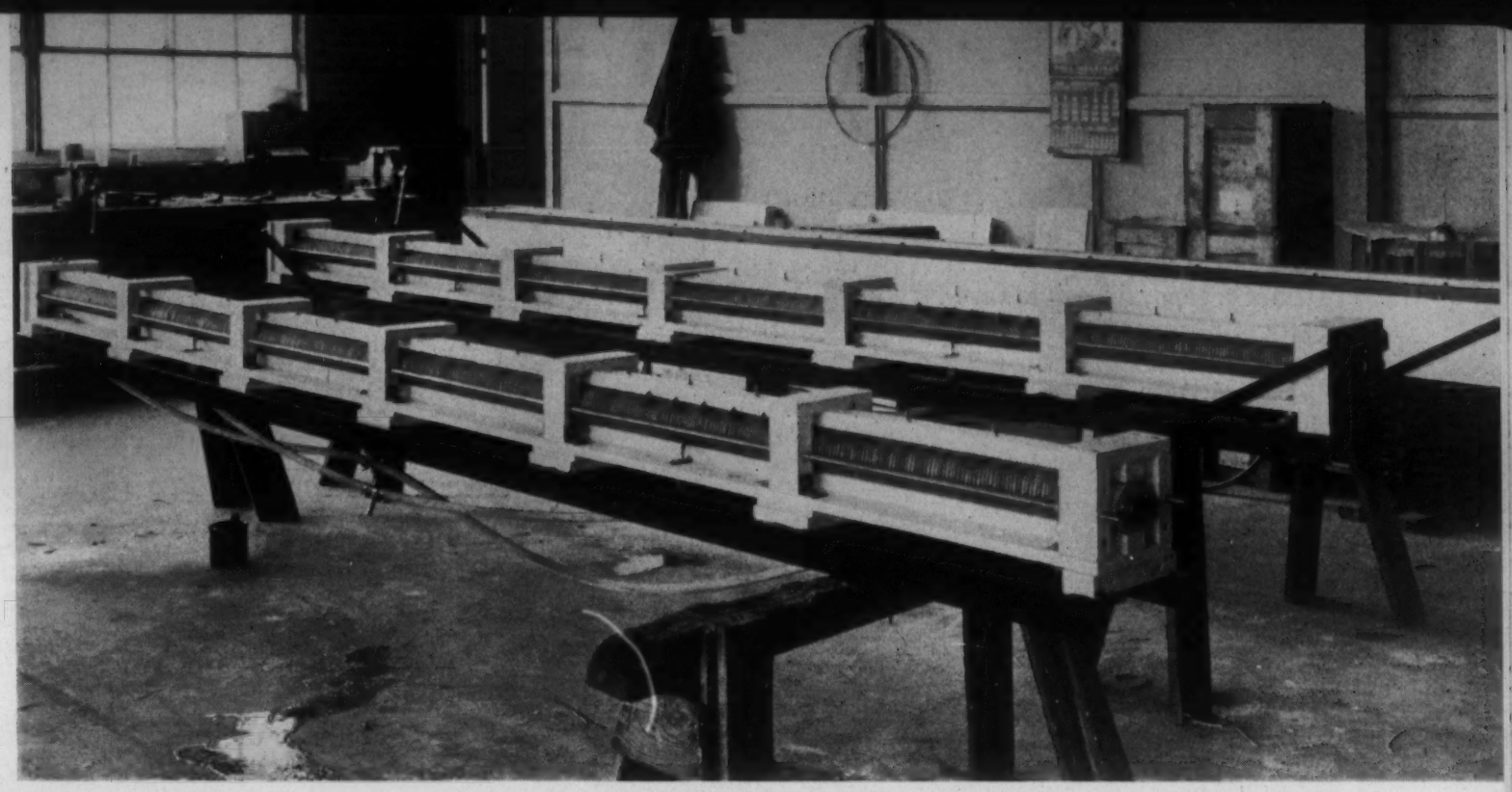

Inductive heating units for heat treating razor blades as they were being constructed in the shop of the Ajax Electrothermic Corporation.

Heat Treatment and Paint-Drying by Inductive Heat

By H. G. REMMERS*

INDUCTIVE ELECTRIC HEAT—heat which is induced within a metal by high-frequency electric current—has been successfully applied to the melting of metals, is widely used in this and foreign countries for this purpose, and is familiar to most metallurgists. The speed and control of heating make the method of interest for the heating of solid metal as well.

This type of heat has already made marked strides in several industrial applications to solid metal and other fields are opening up. Some of the successful and some of the possible uses for inductive heat treating, paint-drying, differential heating, and so on, as developed by the Ajax Electrothermic Corporation, Trenton, N. J., are briefly discussed below.

Heat Treating Razor Blades

In heat treating, a most interesting commercial application is by a large safety razor manufacturer. The heat treatment of razor blade steel is a delicate operation. The steel, in perforated, long thin strips, must be brought up to the proper temperature as quickly and as accurately as possible in order to bring out the best qualities. The induction furnaces are of the muffle type, each 14½ ft. long and graded as to temperature in three zones.

Close temperature control is essential and is one of the features of the high frequency furnace in razor blade hardening. This control is obtained by the use of a magnetic device operating from the cold strip after it emerges from the quenching-blocks adjacent to the furnace. The temperature varies less than 50 deg. F. plus or minus from that which is desired. It may be necessary to raise the power, and therefore the temperature over a range of about 50 deg. F., depending upon the magnetic properties which are related to the carbon content and the proper hardening temperature. When the magnetic properties demand a change in temperature level, the furnaces are capable of raising or lowering this level as much as 40 deg. F. a minute.

The muffle wall of the induction furnace for heat treating razor blades is only 1/10 in. thick. It is immediately surrounded with about 3/4 in. of asbestos and outside of the asbestos is located the water-cooled induction coil. This means that as soon as the power is cut off, the furnace begins to cool whereas with other

Heating a steel tube progressively by induction for drawing, heat treating, and so on.

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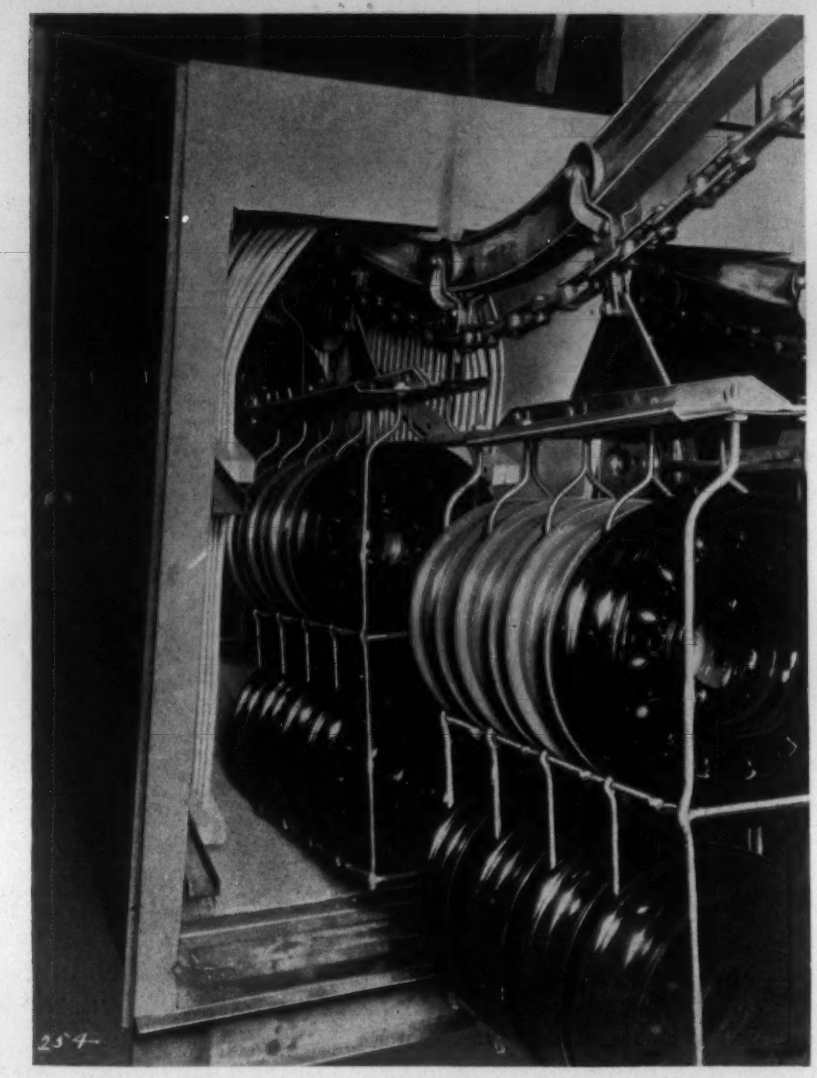
types of furnaces in which there is more heat storage capacity, the muffle may rise in temperature after the source of the heat has been cut off. The induction furnace responds very rapidly to the control device, raising or lowering the temperature of the strip very speedily to the correct temperature required for the section of the strip being hardened.

The company, whose equipment is referred to, operates 18 of these high-frequency furnaces. Regulation of the atmosphere to avoid oxidation is easily attained. The fact that inductive heating makes it possible quickly to lower or raise the temperature of the steel is claimed a decided advantage.



Automobile wheels, freshly painted or enamelled, as they enter inductively heated drying ovens in the plant of the Chrysler Corporation.

Hardening Steel Surfaces

Another application is a novel one—the heat treating and subsequent hardening of steel surfaces in selected locations. This has been designated "differential heat treating." For example, it is desired to harden a selected surface of a steel part—a feat which ordinarily could not be accomplished by present day methods. It is desired to increase the hardness of some bearing surface in a location where hardening by carbonizing or nitriding would be impracticable. By the use of suitable apparatus and the application of inductive heat, the designated part can be very quickly brought up to the hardening temperature after which water is sprayed on the part for quenching. The result is a highly hardened surface in a difficult or ordinarily inaccessible spot without the heat having materially hardened the rest of the metal.

Other Uses for "Differential Heat Treatment"

Numerous other possibilities of the application of induction or differential heat treating exist. Some suggested ones are for rail ends and for oil well casing. In the case of rail ends, it is frequently necessary to build up by welding the ends of rails which have been distorted or flattened in service due to the intermittent pounding of the wheels. By heat treating the ends of new rails by inductive heat, followed by sudden cooling, a hardness is obtainable which, it is believed, would greatly lessen end batter. Some of the heat-treatment methods, hitherto suggested for rail ends even though badly lacking in provision for accurate temperature control, seem to give useful results, and a more precise method of heat treatment should attain these results far more uniformly.

In oil drilling, the driving of tubing as casings often results in the breaking or deterioration of the ends of the tubes. Here again it is expected that, by inductively heat treating and hardening, the life of casings can be considerably lengthened.

Inductive differential heat treating may also find a use in preparing surface-hardened cylinder sleeves for automobile engines. Such sleeves can be quickly and easily inserted in the cylinders. Their wear resistance should keep the cylinder in proper shape without frequent grinding, and when repair is necessary, it can be done by the insertion of a new sleeve. Minimizing the time a truck or bus engine is down for repairs is well worth while.

Heat Treating Tubing

The possibilities of heat treating tubing and cylindrical articles in general, seem rather great. It is believed that the speed and accuracy of this type of heating, intelligently applied, will help in producing high grade results. Plausible explanations for the good results of the method are that the heating is on the inside out and not from the outside in, that the penetration of the heat is sudden, thorough and easily regulated.

Drying by Inductive Heat

In a decidedly different field inductive heating has already proved its adaptability and effectiveness. This is in drying materials which have been painted, lacquered, or enameled—especially where an unusually superior finish is desired and where quality of finish is a prime consideration.

The Chrysler Corp., Detroit, has installed inductively heated drying ovens for drying its painted and enameled parts. "From the inside out" is the slogan of this method of drying. The metal is heated by induction as it passes through the oven so that the volatile matter is first driven from the portions next to the metal. This means a thicker coat of enamel can be applied for one baking. The result is proved to be a superior finish with less cause for rejections. The drying time is fast and heavy parts heat relatively faster than when the heat is applied by hot air in the conventional manner. The absence of a high heat in the ovens is also pointed to as a safety feature. The company referred to is drying paint on wheels, radiator shells, lamps, tire covers, motor blocks, and other parts.

Since success in heat treating razor blade steel and in drying painted and lacquered steel parts has been established, it is logical to expect extension of the methods to other problems.

Effect of Bismuth as an Impurity on the Structure and Allotropic Transformation of Tin*

By C. W. MASON† and W. D. FORGENG‡

IN attempting to study the allotropic transformation of single crystals of tin, prepared by the method of Obriemov and Shubnikov[1], difficulty was experienced in causing them to invert to the gray modification. A temperature of —40 deg. C., as recommended by Cohen and Van Eijk[2] was ineffective, over a period of six months. As a means of encouraging the transformation, the following methods were tried: Local cold work; rolling to sheet form; remelting one end of the crystal; fusing on to a single crystal a partially transformed piece of tin; placing filings of either modification in contact with the other. None of these aids was effective, even in the presence of an electrolyte such as HCl or $(NH_4)_2SnCl_6$.

In view of the fact that tin from the same source as that used for single crystals when cast in a cold mold transformed readily in less than 24 hrs., usually spontaneously**, it seemed evident that the very slow crystallization and cooling involved in the method of growing the single crystals were responsible for the anomalous behavior. An anneal of 24 hrs. at 200 deg. C. caused the chill-cast specimens of tin to lose their ability to transform; furthermore, remelting single crystals and chill casting them restored this property. Electrolytic crystals of tin, as formed from a solution of $SnCl_2$ and HCl, transform to the gray modification in a few hours.

This "heat treatability" of supposedly pure tin pointed to the presence of some impurity, and metallographic examination showed that marked structural differences existed, depending on the thermal history of the specimens used in the above experiments.

Fig. 1 shows the structure of supposedly pure tin, as received. The structure of this material, as cast into a graphite mold at room temperature, is similar. Single crystals show a coarser structure of much the same character but with the pattern of dark regions uniformly oricnted, as is consistent with their dendritic formation. On annealing for 50 hrs. at 200 deg. C. these structures disappear and the alloy appears homogeneous, as shown in Fig. 2. The impurity segregated in the dark regions has evidently been brought into uniform solid solution. Local remelting of such a homogeneous specimen, with rapid cooling, restores the duplex structure (Fig. 3), giving a fine pattern which may also be obtained by quenching molten tin in water.

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* This article is based on a portion of a thesis submitted by W. D. Forgeng for the degree of Doctor of Philosophy at Cornell University.

† Professor of Chemical Microscopy, Department of Chemistry, Cornell University.

‡ Present address, Union Carbide and Carbon Research Laboratories, Niagara Falls, N. Y.

** It was found that contact with tin, which has previously been gray and has not been remelted, is practically essential to start the inversion, unless the laboratory has been "inoculated" by previous work with gray tin, when such seeding is rarely necessary.

When Traces Mean Something

WE have all been told, in Freshman chemistry, of the Russian tin organ pipes that disintegrated, in the winter time, from the "tin pest." When Byrd was arranging his first expedition to the South Pole, he was worried for fear his tin cans would become uncoated and all the soldered joints come apart. Yet when one tries to make gray tin, it often turns out to be a tough job. This article explains why tin doesn't always act the same in this regard.

It also points the way toward further purification of the purest known tin. This change is only from a purity of 99.99— to 99.99+, but it represents the taking out of over a quarter of the remaining impurities. And it shows that 0.001 per cent Bi does not inhibit the transformation to gray tin, while 0.0035 per cent does. Truly, these are days when "traces" mean something.

Metallographic Preparation of Tin

Because the structures to be described have not previously been reported, and because the method of revealing them is new and must be followed rather closely, it is given in some detail:

The usual surfacing operations on files and abrasive papers are carried out, through No. 000 emery paper. The specimen is then transferred to a wool broadcloth-covered lap, charged with No. 600 Carborundum flour in water, and running at less than 400 r.p.m. At first the direction of abrasion should be crosswise of the scratches from the last emery paper, and when these are removed the sample should be carried slowly around the wheel.

The next stage of polishing is carried out on a similar lap, charged with emery or alumina, which has been levigated to such fineness that it will not settle more than 6 ins. through water in 3 hrs.

After removal of the last traces of scratches from the No. 600 Carborundum lap, the sample is rinsed with water and alcohol, and dried in an air blast.

Etching is carried out by swabbing gently with cotton soaked in a 5 per cent solution of

nitric acid in *absolute* ethyl alcohol, and should be deep enough to remove any "flowed" surface layer. The specimen is repolished on the last lap, and re-etched lightly. Ordinarily this is sufficient to reveal the structure, but repeated light polishings and etchings may be necessary in the case of very fine structures.

The use of absolute alcohol is essential. If water is present, as in ordinary 95 per cent alcohol or when etching a sample while still wet, only grain boundaries and oriented lustre are revealed, and the structures which explain the anomalous behavior are completely masked. The etchants commonly employed for tin are all unsatisfactory in this respect, though swabbing with a 5 per cent aqueous solution of silver nitrate, or electrolytic etching, will reveal these structures more or less imperfectly.

Material Used

Various samples of supposedly pure tin were studied: Baker's C. P. grade (used in the preliminary experiments); Merck's and Kahlbaum's C. P. grades; Straits tin (American Smelting & Refining Co.); electrolytic tin (National Lead Co.) and "Chempur" tin (Capper, Pass & Son, Ltd.); and U. S. Bureau of Standards, standard sample No. 42 B. All of them, when etched according to the above procedure, showed duplex structures (Fig. 1) of closely similar nature, especially when recast under similar conditions.

The "Chempur" tin, from which the standard sample 42 B was obtained, was selected by the Bureau of Standards as the purest tin obtainable; it has been used by various investigators in England, for similar reasons. The Bureau of Standards' analysis is as follows:

Bismuth	0.0035 per cent.
Copper	0.0017 per cent.
Lead	0.0035 per cent.
Iron	0.0017 per cent.
Antimony	0.0018 per cent.
Sulphur, arsenic, zinc, not detected.	

This tin was used for the experimental work, but materials of other makes were compared with it sufficiently, so they all may be said to show substantially similar behavior.

Purification of Tin

It was at first assumed that, since the metallic impurities were so low in the tin used, non-metallic impurities were the cause of the structures described above.

To remove oxygen, six hours' heating in hydrogen at 800 deg. C. was employed[3]. The structure persisted, and bubbling hydrogen through the molten tin had no effect. By these methods sulphur, phosphorus, and arsenic should also have been eliminated.

Fusion with sodium cyanide (fire assay method) had no effect. Heating in nitrogen or ammonia, to permit any possible nitride formation, was also without influence.

Fractional crystallization of 200 grams of the molten tin did not give any significant structural differences between the first and last fractions.

Spectrographic examination of the various chemically pure grade tins showed the following metallic impurities common to each: Bismuth, copper, iron, lead and zinc. Electrolysis, using a bath containing 71 grams $SnCl_2$ per liter, and 215 per cent conc. HCl by volume, with a tin anode[4] gave a deposit of tin which, when remelted under oil, showed the characteristic duplex structures.

Cathodic deposition[5], from an electrolyte prepared by extracting with water a fused mixture of tin, sulphur and soda, gave no structural purification of the tin obtained. Various other electrolytes such as sulphuric acid, hydrofluosilic acid, or sodium stannate, were of no better effectiveness.

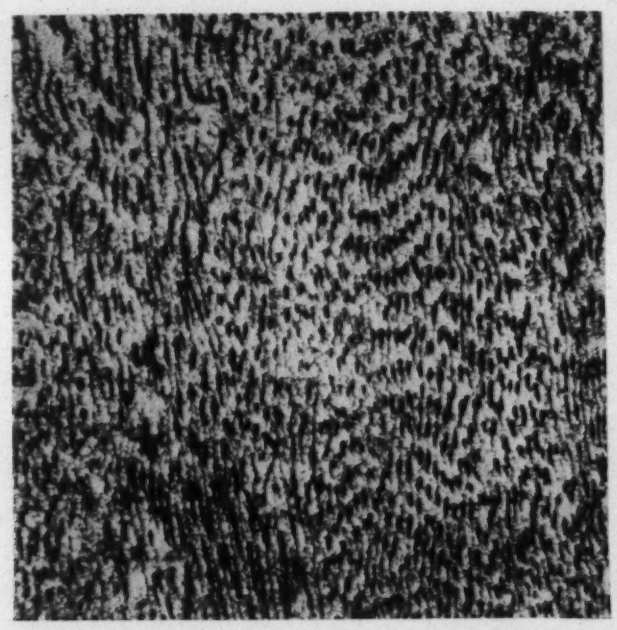

Fig. 1 (Left). "Chempur" Tin, as Received. 50 diameters. Duplex Structure, Typical of Ordinary "C.P." Tins.

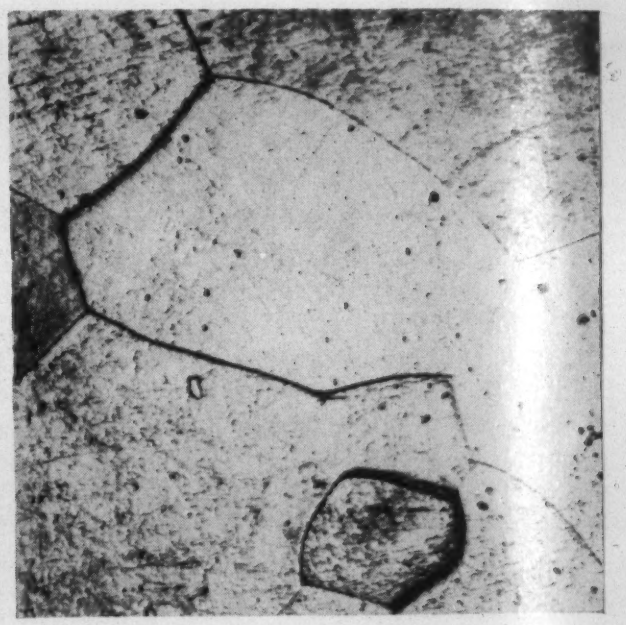

Fig. 2 (Right). "Chempur" Tin, Annealed for 50 hrs. at 200 deg. C. 50 diameters. Homogeneous Solid Solution.

Structurally pure tin was finally obtained from a bath consisting of 250 grams $SnCl_2.2H_2O$ (Baker's or Kahlbaum's) to which was added one litre of water, containing 10 cc. of concentrated nitric acid. Colloidal "metastannic acid" immediately forms as a flocculent or gelatinous precipitate, which remains during the electrolysis and evidently, by virtue of its well known absorbing properties, removes most of the impurities present in the solution. A short platinum wire was used as anode and a small graphite rod as cathode. Current variations from 0.5 to 6.0 amp. and 6 to 10 volts appeared not to affect the purity of the product; the current density varied over a wide range as the deposit grew in size.

The refined tin is deposited as platy or dendritic crystals, some weighing as much as several grams. They are easily washed free of the electrolyte with water, rinsed in alcohol, then ether, and allowed to dry. By melting under oil, massive tin is obtained (Fig. 4), which when etched shows only the oriented luster and grain outlines common to pure metals. Neither severe

chill casting nor very slow cooling develops any other structural features, such as were so consistently produced in ordinary "pure" tins.

Spectrographic examination of the purified tin showed that it contained small amounts of copper, lead, and iron. In an attempt to ascertain the cause of the structures previously described, alloys containing 0.001, 0.01, 0.1, and 1.0 per cent of lead were prepared as follows:

The tin was melted under oil in a porcelain crucible, and the requisite amount of lead was added as foil, so that it could be plainly seen melting into the surface of the tin. Quenching these molten alloys gave no structure corresponding to that obtained from "pure" tins, under similar conditions. Similarly, the addition of copper, iron, or zinc, in quantities far exceeding the amounts of the impurities shown in the Bureau of Standards analysis of "Chempur" tin failed to reproduce the characteristic structure.

structure is obtained on casting from 300 deg. into a graphite mold at 25 deg. C. which is very similar to that commonly found in "C.P." tins, and which occurs throughout the range up to about 0.01 per cent Bi. (Fig. 5)

The similarity is much more apparent when the structure obtained on water-quenching molten tin containing 0.004 per cent Bi. (Fig. 6) is compared with that of "Chempur" tin similarly quenched (Fig. 3). Annealing this alloy destroys the duplex character and gives a structure like Fig. 2. In other words, the structural features of "Chempur" tin, containing 0.0035 per cent Bi, are duplicated in all respects by electrolytically purified tin to which 0.004 per cent Bi has been added, and it seems justifiable to conclude that bismuth is the essential impurity to which such structures are due.

The structures in tin which have been described do not represent equilibrium states; even those obtained by slow solidification are unstable. The composition lies far below the limit of solid solubility of bismuth

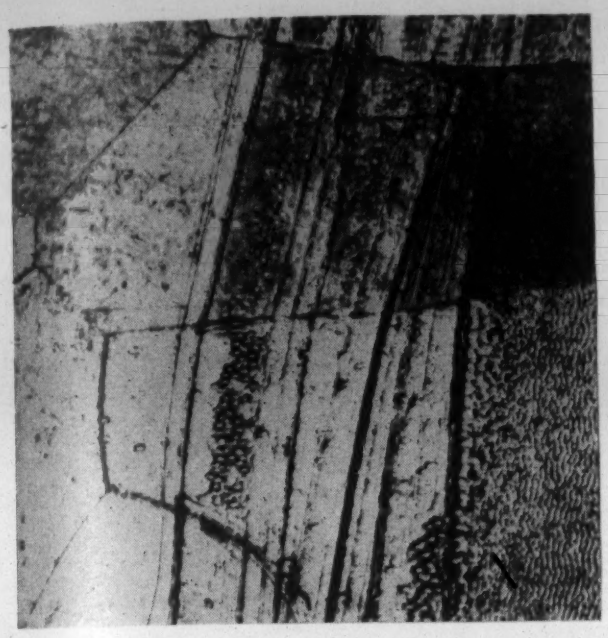

Fig. 3 (Left). Annealed "Chempur" Tin, Right Edge Remelted and Quenched. 50 diameters.

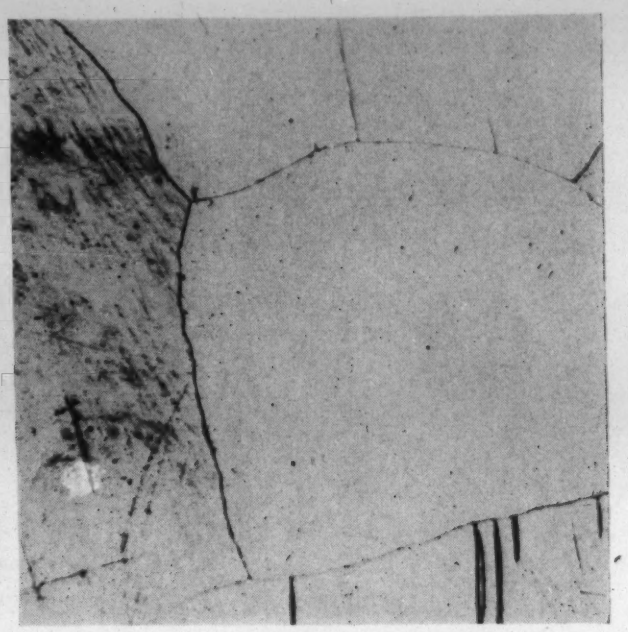

Fig. 4 (Right). Purified Tin, as Cast. 100 diameters.

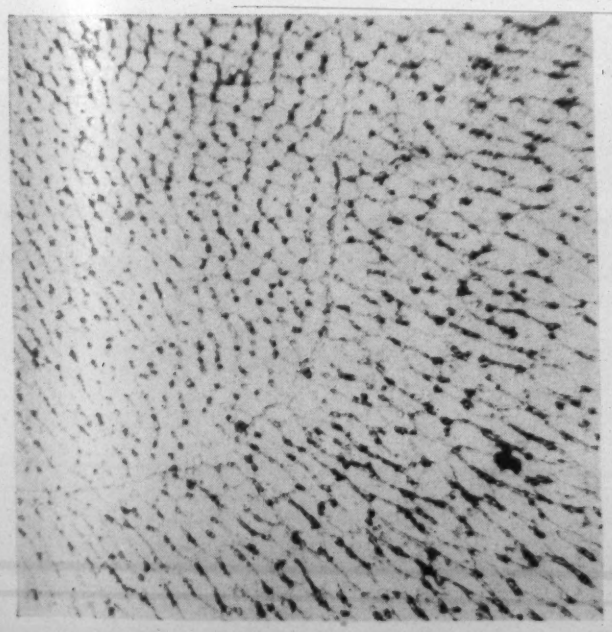

Fig. 5 (Left). Purified Tin, 0.004 per cent Bi as Cast. 50 diameters.

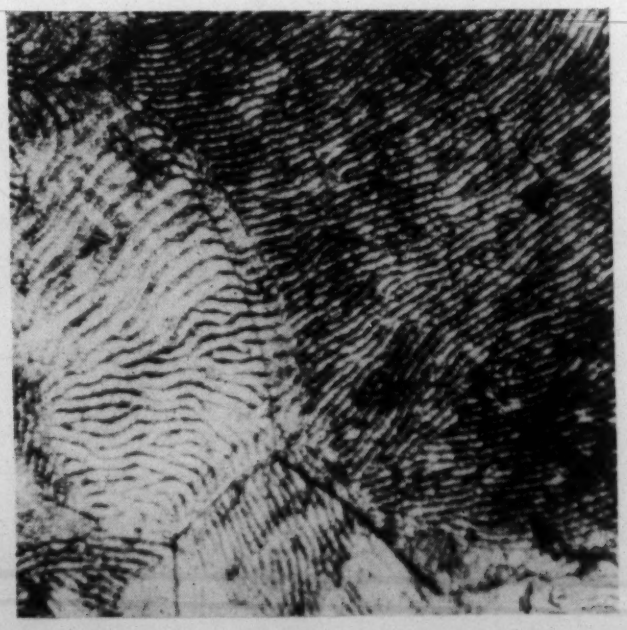

Fig. 6 (Right). Purified Tin, with 0.004 per cent Bi Quenched from Melt. 100 diameters.

Effect of Small Amounts of Bismuth on Structure of Tin

The electrolytically purified tin is entirely free of bismuth, as far as can be determined spectrographically by sparking or arcing between tin electrodes; the ultimate Bi line at 3067.73 Å is absent. Bismuth is the only metal originally present and finally absent; when as little as 0.001 per cent Bi is added to pure tin, a

in tin (about 1.0 per cent at room temperature), and the appearances must be ascribed to coring of the tin crystals as they separate from the melt. The arrangement of the dark pattern of bismuth-rich regions corresponds to the interstices of a dendritic growth, varying in fineness with the rate of formation of the dendrites.

Tin has a very strong tendency to grow in this habit,

and even the slowly formed single crystals are actually dendritic; the cored pattern is of course drawn out in the direction of their growth (Figs. 7 and 8). The fine structure of specimens quenched from the melt is of the same nature, as shown by perpendicular section through the pseudo-lamellae.

This extreme degree of coring seems exceptional but its revelation is solely dependent on the etchant used, and cases of this sort may be found in other alloys. The segregation of small amounts of phosphorus in steel, so clearly shown by Oberhoffer's reagent, is an example.

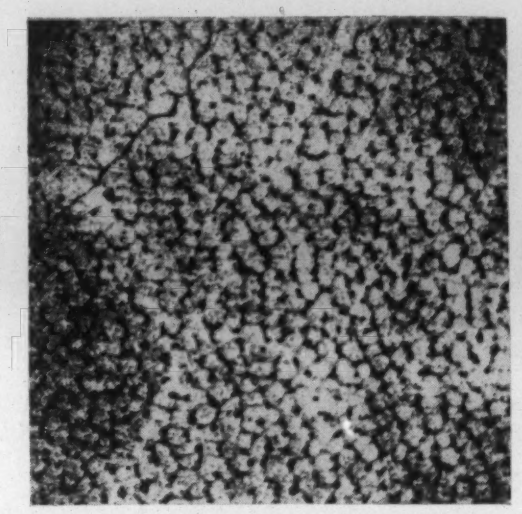

Fig. 7. Single Crystal of "Chempur" Tin, Transverse Section. 25 diameters

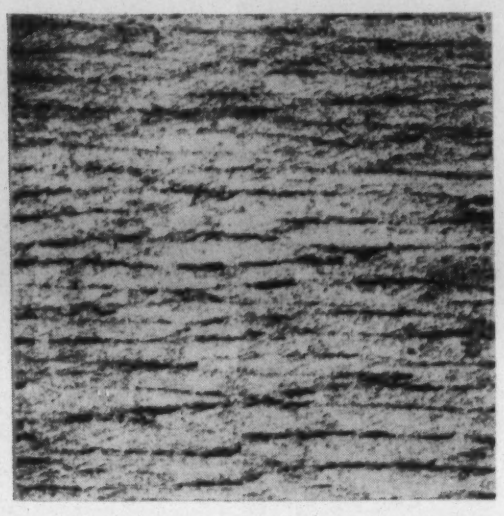

Fig. 8. Single Crystal of "Chempur" Tin, Longitudinal Section. 25 diameters

Naturally, the more extreme the coring, the purer the primary central ribs of the dendrites. Hence the allotropic transformation from white to gray tin, which will not take place in the annealed and homogeneous solid solution containing 0.0035 per cent Bi, can proceed uninhibited along the practically pure tin in the interior of the cored crystals. This behavior was observed microscopically in the coarser structures, the transformation always starting in the interior of the dendrites and being delayed by their boundaries.

The bismuth-rich outer layers might at first be expected to act as "insulators," but since the crystallization is rapid, with a marked temperature gradient, the primary crystals grow continuously and isolated grains are not likely. Thus the transformation can progress through the entire mass. The single crystals which refused to transform had been solidified slowly enough to allow some bismuth to be present in solid solution in all parts of the crystal.

Of various common metals, bismuth is the most effective in inhibiting the transformation, according to Tammann and Dreyer[6]. Their work apparently included no special precautions to bring Bi into continuous uniform solid solution, hence its influence would be much less than when dissolved in all parts of the tin crystals. They regard 0.1 per cent Bi as being necessary for more or less complete protection against "tin pest," but we have found that as little as 0.0035 per cent Bi is a preventative, provided that extreme coring is avoided by slow solidification or subsequent annealing. However, 0.001 per cent Bi in uniform solution does not inhibit the transformation.

Conclusions

1. Supposedly "chemically pure" tins "as cast" commonly show cored structures due to as little as 0.0035 per cent Bi.
2. Etching with 5 per cent HNO_3 in absolute alcohol is necessary to reveal these.
3. Allotropic transformation of white to gray tin is inhibited by this content of Bi in solid solution, unless extreme coring produces relatively pure interior ribs along which the inversion may progress through the crystals.
4. An electrolytic method for the preparation of structurally pure tin is described.

Acknowledgment

The writers' thanks are due to Dr. C. B. Stilson for assistance in the preliminary stages of this investigation.

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Note on the Carburizing of Copper Steels

By S. EPSTEIN* and C. H. LORIG*

THE GROWING IMPORTANCE of copper as an alloying element in steel raises the question whether such steels are suitable for carburizing. An 0.15 per cent carbon, 1 per cent copper steel will give about 100,000 lb. per sq. in. tensile strength with good ductility[1] after quenching and tempering at about 350 deg. F., as is usual for case-hardened parts. The properties of the core of such a steel, therefore, approach those of more expensive alloy carburizing steels, as given recently by McMullan[2].

Although there seems to be no commercial history of the use of copper steel for carburizing, there have been unpublished reports of casual observations that copper alloy steels may give an abnormal carburizing structure or fail to carburize evenly. The latter might well happen if the steel is oxidized before carburizing, since it is known that iron is more readily oxidized than copper with the result that a thin layer of metallic copper forms below the iron oxide scale. This has been fully discussed in the monograph on Alloys of Iron and Copper[1]. Such a copper layer would hinder carburization just as local copper plating of parts to be carburized is used to prevent carburization where it is not wanted.

However, no one would expect to do good carburizing upon oxidized surfaces. On a clean machined surface the only copper present in a copper alloy steel is in solid solution, in which state it should not act as a barrier to carburization. Nor would copper seem to be one of those elements which causes abnormality.

In order to find out how copper steels act in these respects, a series of structural steels of varying copper content which was available was carburized. The specimens in the form of rods, 1 cm. sq., were pack carburized in a commercial carburizer for approximately 10 hr. at 1725 deg. F. Two sets of specimens were carburized, one with the surfaces as machined, and the other with the surfaces oxidized after machining, by heating in air 1 hr. at 1725 deg. F. before carburizing. The depth of the carburized layer was then

Table 1.—Depth of Carburized Layer in Inches.

Composition		Samples with Machined Surfaces			Samples with Surfaces Oxidized by Heating in Air 1 Hr. at 1725° F.		
Cu %	C %	On One Side	On Side at 90 Deg. to the Other	Average	On One Side	On Side at 90 Deg. to the Other	Average
...	0.17	0.055	0.053	0.054	0.066	0.066	0.066
0.58	0.15	0.057	0.057	0.057	0.055	0.057	0.056
1.05	0.16	0.061	0.059	0.060	0.068	0.066	0.067
1.54	0.13	0.051	0.051	0.051	0.049	0.051	0.050
2.05	0.09	0.051	0.051	0.051	0*	0.049	0.025*
2.88	0.13	0.055	0.057	0.056	0.061	0*	0.031*
3.77	0.11	0.012*	0.028*	0.020*	0.032*	0.045	0.039*
...	0.27	0.061	0.066	0.064	0.053	0.061	0.057
0.58	0.30	0.066	0.068	0.067	0.070	0.070	0.070
1.04	0.30	0.064	0.061	0.062	0.066	0.061	0.064
1.46	0.27	0.066	0.064	0.065	0.037*	0.051	0.044*
1.99	0.26	0.064	0.064	0.064	0.070	0.066	0.068
2.84	0.28	0.061	0.061	0.061	0.041*	0.053	0.047*
3.69	0.28	0*	0.008*	0.004*	0.024*	0.032*	0.028*

* Shallow or no carburized layer.

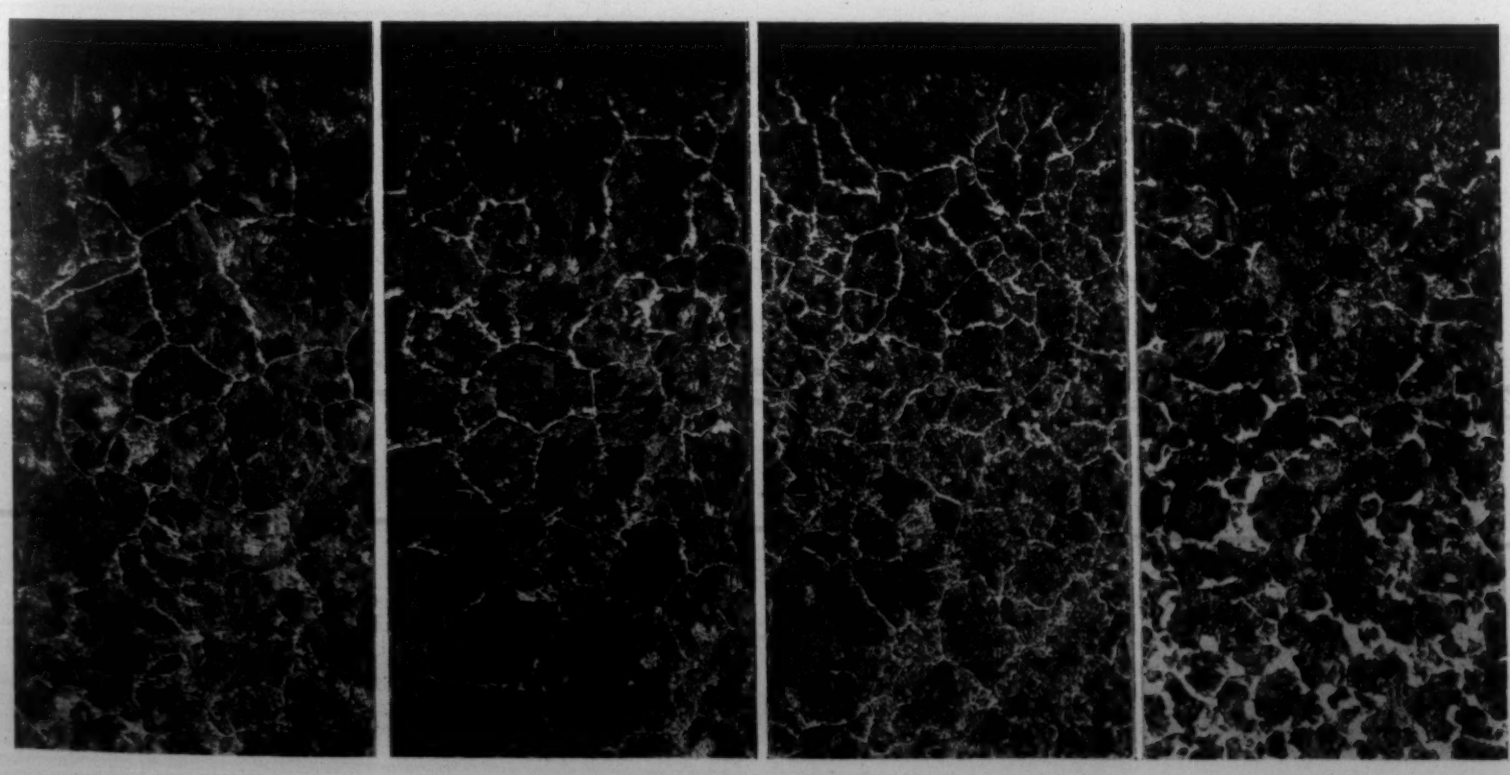
* Metallurgist, Battelle Memorial Institute.

[1] J. L. Gregg and B. N. Daniloff: Alloys of Iron and Copper, 1934, p. 192.

[2] O. W. McMullan: "Physical Properties of Case Hardened Steels," Preprint No. 7, A.S.M., October, 1934.

Surfaces Clean-Machined Before Carburizing. See Table II

Fig. 1. Fig. 2. Fig. 3. Fig. 4.



measured on the microscope with a micrometer ocular, the inner boundary of the carburized layer being taken at a carbon content of about 0.8 per cent; two sides of the sections of the 1 cm. sq. rods at 90 deg. to each other were measured. The results are shown in the accompanying tables and photomicrographs, all at 100 diameters.

The as-machined samples carburized uniformly up to a copper content of 2.8 per cent; the samples with 3.7 per cent copper, however, gave shallow and uneven carburized layers.

The oxidized samples carburized fairly uniformly up to a copper content of about 1 per cent; beyond this copper content the lower carbon series began to show very shallow and uneven carburized layers at about 2 per cent copper and the higher carbon series at about 1.5 per cent copper. The carburized layers of all of the samples showed a very normal structure of intermediate grain size.

On the machined samples the results indicate that copper in solution in steel does not cause uneven carburization up to a copper content of about 3 per cent, which is much higher than would ordinarily be used in copper structural steel. Copper in higher amounts tends to prevent carburization, possibly because the copper is then not all in solution [1, 3], but is present in part as practically pure copper.

Table II.—Surfaces Clean-Machined Before Carburizing

Original Composition	Fig. 1	Fig. 2	Fig. 3	Fig. 4
Copper, %	0.00	1.05	2.05	3.77
Carbon, %	0.17	0.16	0.09	0.11
Aver. Depth of Case, In.	0.054	0.060	0.051	0.020*

* At the spot shown in the photomicrograph, the case depth is considerably less than the average.

In the oxidized samples uneven carburization began to appear at lower copper contents. The explanation no doubt is that during oxidation iron is preferentially oxidized so that a thin layer of copper forms beneath the oxide layer, which prevents or hinders carburization. Such a surface layer of copper was actually visible on those oxidized samples which showed uneven and shallow carburization.

It would seem from the above that when precautions are taken to prepare the parts with machined surfaces free from scale, as should be done in all careful carburization anyway, carburized layers of about the same depth and uniformity should be obtained in copper steels of ordinary copper content, as in carbon steel. This is assuming that in the early stages of heating in the carburizing pot the atmosphere is not so oxidizing as to form an appreciable scale on the copper steel, and hence a protective copper film, which assumption appears to be justified from the data shown. The results indicate that copper in steel does not affect the normality or abnormality but that this probably is about the same as it would be without the copper.

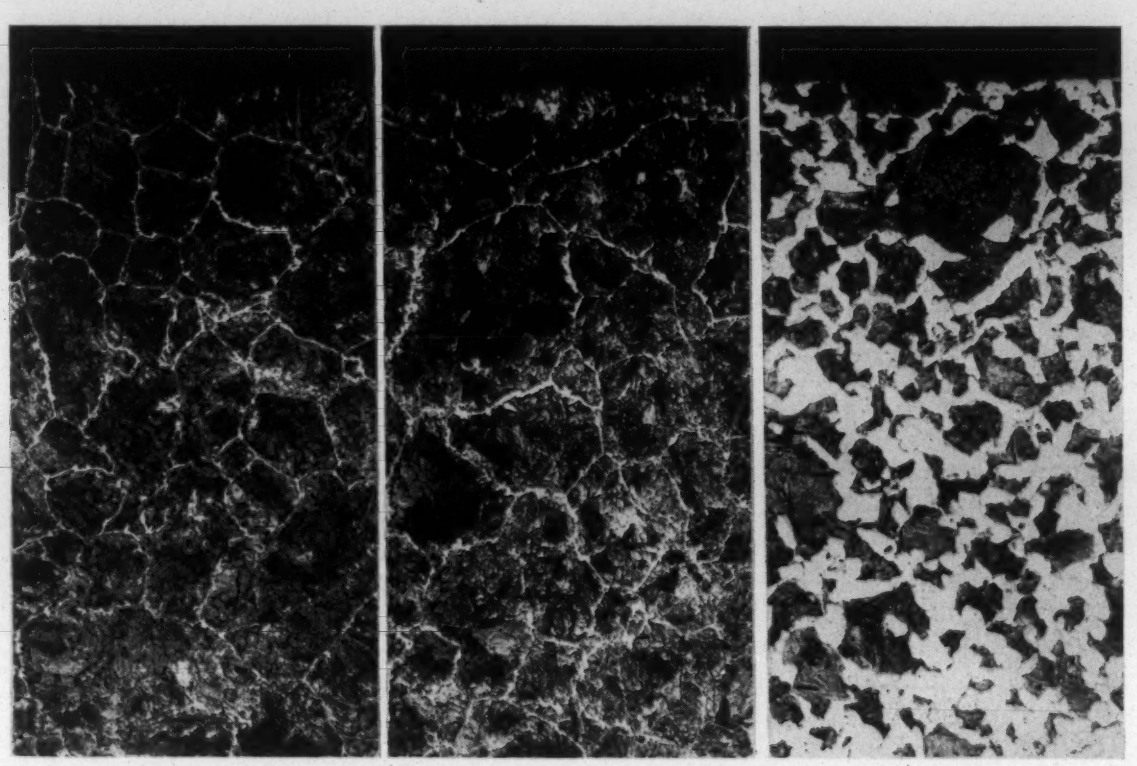


Fig. 5. Fig. 6. Fig. 7.

Surfaces Oxidized before Machining. See Table III.

Table III.—Surfaces Oxidized Before Carburizing

Original Composition	Fig. 5	Fig. 6	Fig. 7
Copper, %	0.00	1.05	2.05
Carbon, %	0.17	0.16	0.09
Aver. Depth of Case, In.	0.066	0.067	0.025*

* At the spot shown in the photomicrograph, the case depth is considerably less than the average.

After carburizing, the samples were water quenched from 1475 deg. F. and Rockwell hardness tests of the cases made. They were all uniformly hard, the average Rockwell C hardness being about 63.

To see whether there is any difference in the rate of decarburization between plain carbon steel and the copper steels, the series of carburized samples was heated for an hour at 1600 deg. F. in an electric muffle furnace open to the air and the extent of decarburization observed in the microscope. The decarburization seemed to be slightly more pronounced in the copper steels, even in the higher copper steels, than in the carbon steels. Evidently the metallic copper layer formed on the copper steels under these oxidizing conditions does not prevent decarburization.

[3] J. T. Norton: "Solubility of Copper in Iron and Lattice Changes During Aging." Metals Technology, December, 1934.

TITANIUM—
Its Uses in Metallurgy*

By PAUL M. TYLER†

AGE-LONG FEARS THAT there are no more worlds to conquer and that there is nothing new under the sun have repeatedly proved groundless, but those who entertain such notions may well consider the recent history of titanium. Although abundant in nature and discovered as far back as the eighteenth century, titanium long belied the implications of the name bestowed by Klaproth in unwitting prophecy. Unable to predict the characteristic properties of the substance he chose a mythological reference not because the Titans were the giant sons of earth and incarnated its primitive forces but simply because he wished "to avoid giving rise to erroneous ideas." Notwithstanding occasional scientific attention, more than 100 years elapsed before there was notable commercial utilization of the element, and only within the last year or two has it found recognition in what may prove one of its leading roles in steel metallurgy.

An Abundant Metal

Many steel-making alloys are sparsely distributed in nature, but titanium is more abundant than any other metallic or submetallic addition used in more than insignificant quantities in steel manufacture except aluminum, iron, and calcium. It is about two and one-half times as plentiful in the earth's crust as carbon and more than five times as plentiful as manganese. Isolation of the metal was attempted by Klaproth as early as 1797, but probably not until about 1910 was titanium approximating 100 per cent purity obtained even experimentally. Pig iron was made with technical success from highly titaniferous ores in the heart of the Adirondacks around 1850. Subsequent attempts to smelt ores of this character in blast furnaces were likewise concerned with the idea of eliminating the titanium in the slag. Mushet, the pioneer British alloy steel maker, obtained over a dozen patents covering the use of titanium in steel before 1862, and gradually it became apparent that titanium-bearing iron had unusual properties. However, Auguste J. Rossi, a French metallurgist who came to the United States in 1870, was the first to evolve an economical process for making high-titanium alloys. By 1895 he had produced ferrotitanium and ferrocarbontitanium, but the commercial production of titanium alloys at Niagara Falls by the Titanium Alloy Mfg. Co., the pioneering concern, dates from 1906.

Up to this time practically the only use for titanium ores was in the form of rutile as a ceramic material for coloring porcelain and to a limited extent for making a mordant used in leather dyeing. A principal use was for tinting artificial teeth, but even though five or ten million dentures are installed annually, the dental profession obviously can never afford a large tonnage outlet. Possible use of chemically prepared titanium dioxide as a paint pigment was glimpsed in

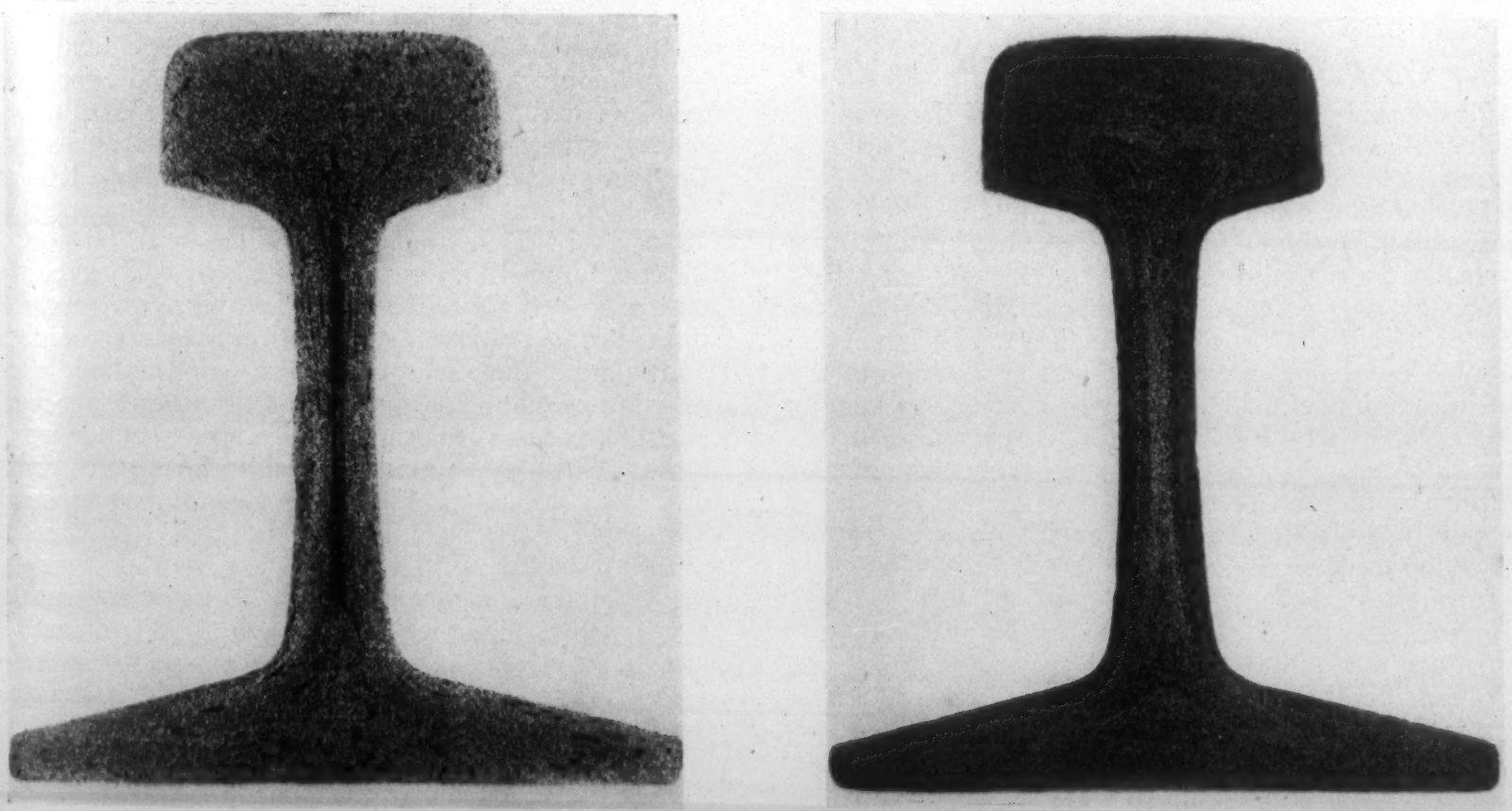


Fig. 1.—Sulphur Print of the Effect of Titanium as a Deoxidizer on Segration in Steel. (a) (Left) Ordinary rail without Ti additions. (b) Rail of Similar Composition Treated with 10 lbs. of Original Ferrocarbontitanium per Net Ton.

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†Chief Engineer, Rare Metals and Nonmetals Division, U. S. Bureau of Mines, Washington, D. C.

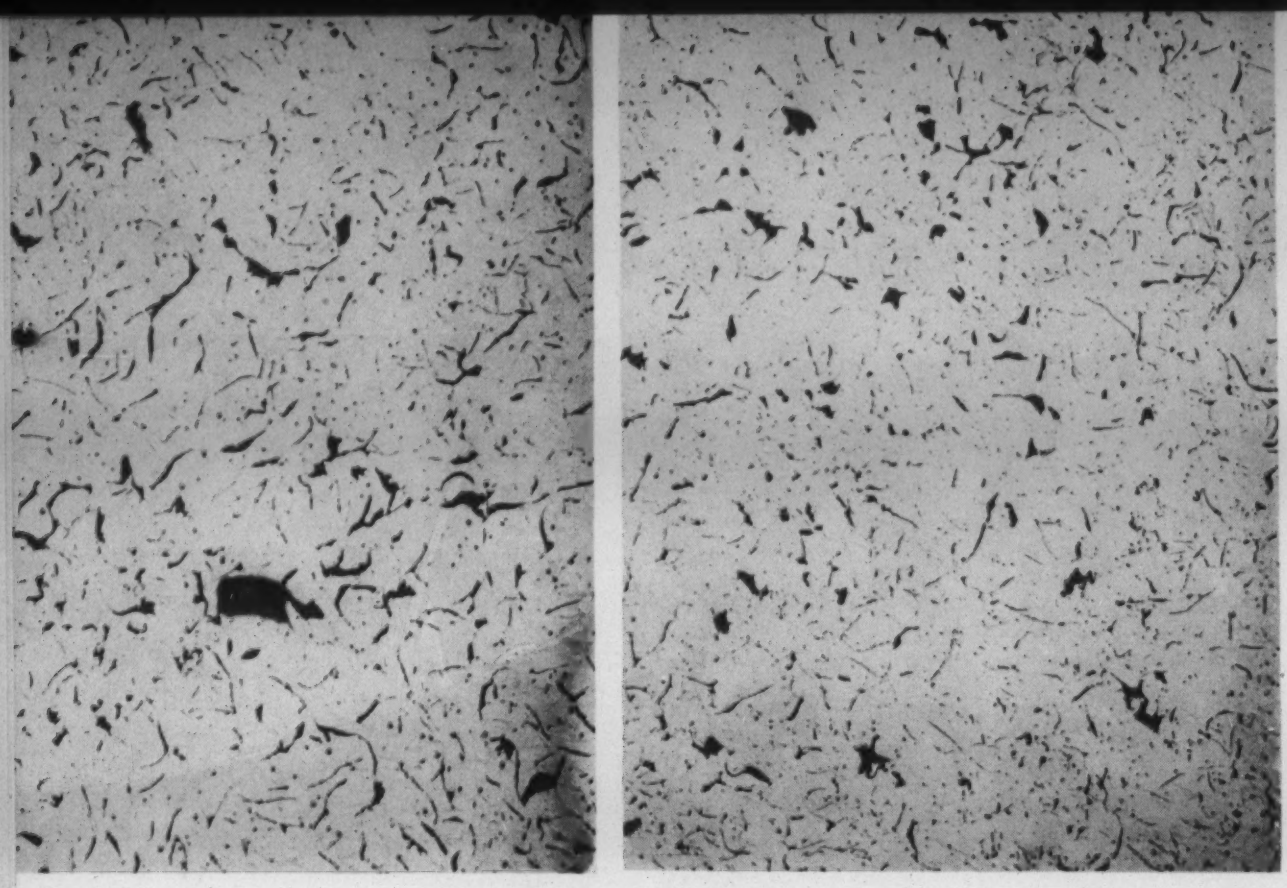

Fig. 2.—Effect of Titanium on Cast Iron. (a) (Left) Untreated. Transverse Strength 2530 lb. in 1 in. Square Section. 50 diameters. (b) Treated with 1 Per Cent Standard Low Carbon Ferrotitanium. Transverse Strength 3050 lb. 50 diameters.

1908, and beginning about 1912, research on titanium pigments was pushed vigorously with such success that building of a factory was started in 1916, although war-time conditions delayed its completion until after the Armistice in 1918. Following the development of composite pigments wherein the relatively costly titanium dioxide is "precipitated upon and coalesced with" barium or calcium sulphate extenders, the consumption of titanium ores in Norway and the United States advanced by leaps and bounds, and gradually other countries took up the manufacture of these remarkable products. Even the onslaught of a world depression failed to suppress the growth of the titanium pigment industry.

A Principal Use Is In Pigments

Considerably more than 90 per cent of the titanium produced has recently been employed in pigment manufacture. Titanium pigments are made from ilmenite, the black double oxide of iron and titanium, which contains ordinarily about 50 per cent TiO_2, rather than from the natural dioxide, rutile, which is employed principally as a ceramic raw material.

In principle the process of manufacture is simple, the titanium being precipitated (after dissolving the ore in sulphuric acid) by hydrolization, either by itself or upon a base of blanc fixe or precipitated calcium sulphate. The hydrated precipitate, whether of the pure oxide or incorporated ("coalesced") with a cheaper base, is then calcined at a high temperature to develop desired physical characteristics and eventually ground to appropriate fineness.

As now conducted on a large scale the processes employed are not unduly costly, but they were developed with considerable difficulty and the early products were not only much more expensive but also much less satisfactory than those made today. Probably no other operations in inorganic industrial chemistry call for more rigid technical control or more knowledge of the latest developments in colloidal chemistry. The refractive index of titanium oxide, 2.55, is higher than that of any other white pigment, and accordingly the hiding power is superior. Other advantages are chemical stability and inertness, brilliance, whiteness, and the fact that it is non-poisonous. Moreover, it resists checking, cracking, and scaling in the paint film.

The range of usefulness of these products extends beyond the paint trade into the manufacture of artists' colors, printing inks, inlaid linoleum, artificial leather, rubber goods, and synthetic plastics. Remarkable results have been obtained in the use of titanium pigments in the highest grades of paper, cosmetics, and rayon; opaque writing paper and wax wrapping papers of astonishing thinness can be made with titanium white, and fiber pie plates impregnated with titanium pigment have been successfully put through the ovens of a Canadian bakery without excessive loss of strength. Titanium pigments are also used for certain finishes in glass, pottery, tile, vitreous enamels, cements, and artificial marble.

Uses for Titanium Metal

Pure titanium metal has found no uses of importance, although it has been made commercially in a small way both in Norway and in the United States by reducing the chloride with sodium and experimentally by treating the oxide with calcium. Titanium filaments were tried out for incandescent electric lamps but were too difficult to make and otherwise less suitable than tungsten filaments. Titanium-copper with 10 per cent Ti, manganese-titanium with 30 per cent Ti, aluminum-titanium (Webbite) with 7 per cent Ti, and one or two other alloys have been employed in a limited way as deoxidizers and degasifiers for copper and sundry non-ferrous alloys. Increasing use in aluminum alloys seems likely as titanium refines grain size, increases strength, and promotes soundness. Titanium carbide, generally mixed with tungsten carbide or molybdenum carbide, is now employed in several brands of super-hard cutting materials. Commercial titanium metal containing 75 per cent Ti has been available for a number of years, and since about 1931 a fairly pure metallic titanium (96 to 98 per cent) has been on the market, but the price of $5 for the ordinary grade and of over $6 per lb. for the newer product restricts its use to small proportions.

A great deal of work has been done on the properties of the metal, but published data regarding it are somewhat conflicting due to the difficulty of obtaining pure speciments for observation. Characteristic is the very high melting point, 1800 to 1850 deg. C., which is higher even than that of platinum. The density, around 4.5, is only about one-half that of copper or nickel but largely exceeds that of the really light metals. At red heat it can be forged or drawn, but at ordinary temperatures it is harder than glass and apparently too brittle to be used alone for any structural purpose. In its chemical reactions titanium resembles silicon, but it is much more active, and the fact that it combines readily with nitrogen is metallurgically

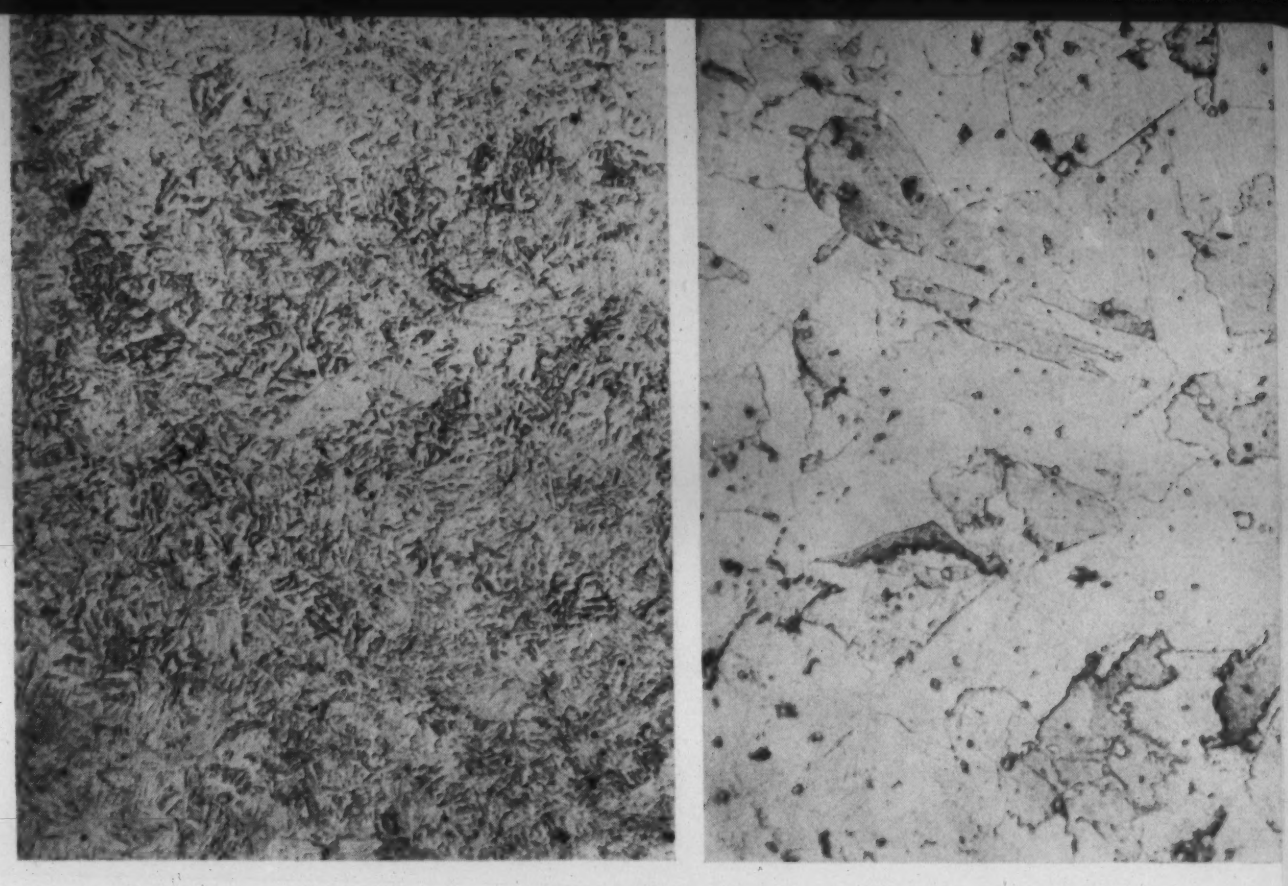

Fig. 3.—Effect of Titanium on Normalized 5 Per Cent Chromium and 0.50 per cent Molybdenum Steel Castings. (a) (Left) Without Ti. Note Martensitic Structure Due to Air Hardening. Etched with aqua regia in glycerine. 200 diameters. (b) Similar Steel with about 0.70 per cent Ti. Note Ferritic Structure, Rendering Steel much Softer and Machinable even though Cooled Rapidly in Air. Etched with aqua regia in glycerine. 200 diameters.

significant. It is one of the very few elements that can be made to "burn" in an atmosphere of nitrogen.

Inasmuch as the metal itself is so expensive, attempts have been made to employ titanium tetrachloride for treatment of various metals. This liquid compound, containing about 25 per cent Ti, is easily prepared and already has found application as a military smoke screen and for minor industrial uses, especially in dyeing. It has been demonstrated that the tetrachloride can be used as a means of introducing titanium into metal baths, either alone or in conjunction with other alloys.

Iron-titanium Alloys

The titanium products chiefly used in metallurgy are the iron-titanium alloys. Ferrocarbontitanium, worth around $137.50 a ton, contains 15 to 18 per cent Ti and 6 to 8 per cent C and is made in the electric furnace. Another grade of ferrocarbontitanium, selling at about $142.50 per ton, is now offered with only 4 to 5 per cent C and 18 to 20 per cent Ti. A slightly lower carbon grade with higher silicon sells for 20 to 25c a lb., and aluminum-reduced ferrotitanium, containing 23 to 25 per cent Ti and virtually carbon-free, sells for around 32c a lb.

The first really extensive use of any of these alloys was to purify bessemer rail steel; in 1910 over 250,000 tons of rails were treated in this manner. With the substitution of open-hearth for bessemer rails this use dropped off rapidly, but meanwhile ferrocarbontitanium found other applications—in the treatment of special steel forgings and steel and iron castings. During the World War it was found that ferromanganese additions might be reduced by one-half when sufficient titanium was added in the ladle.

Until about 1931, titanium was valued by most steel metallurgists largely because its dioxide is more stable than that of iron and, being a fluxing agent, tends to remove other oxides that may be included in the steel. In a paper[1] delivered in February, 1932, the present author summarized existing practice as follows: "Titanium is not an alloying agent and is used in only small amounts (up to about 4 lb. per ton except for high carbon steels, notably rails, which may take 13 lb. per ton) in the ladle as a deoxidizer and scavenger . . . Now used extensively in making sheet bars (especially) for galvanized sheets) and also for roll shells, various castings and forgings, including chilled-iron car wheels and sundry machinery parts."

There was discussion as to the relative virtues of aluminum or titanium and also with respect to those of ferrocarbontitanium and the even higher priced ferrotitanium produced by the alumino-thermic reaction (and consequently containing 5 per cent or more aluminum). The question of the successful use of titanium in metallurgy had been answered in the affirmative, but as one well-informed observer expressed it before a meeting of metallurgists in Washington early in 1932, no great metallurgical use of titanium was yet in sight "since the properties of these alloys can be obtained in alloys of cheaper constituents."

The usefulness of titanium in effervescing steels for plates and sheets was widely admitted, and there was a growing feeling that additions of titanium alloys to iron castings resulted in high strength, easily machinable iron—provided the alloy could be made to dissolve in the molten iron at ordinary foundry temperatures and exert its refining influence on the graphite to close up the grain. Good summaries of the effects of titanium on gray iron have already appeared.[2] The graphitization produced by titanium, which acts in this respect somewhat like silicon, is difficult to explain in view of its strong affinity for carbon, but the action in cast iron is doubtless different from what it is in steel because the temperatures are lower.

Titanium As An Alloy

Mention has been made of the Mushet patents on titanium steels around 1860. Occasional references to titanium as an alloying agent appeared in Europe early in the present century, but until better melting equipment became available excessive difficulty was encountered in obtaining enough residual titanium in the solid metal to exhibit alloy effects. After completing its scavenging action, titanium naturally tends to combine with both the oxygen and nitrogen of the air and to reduce the slag and everything else with which it comes in contact. As far back as 1920, the literature records references to the use of titanium for rendering nickel alloys forgeable, but it was probably not until the Westinghouse laboratories announced the discovery of Monel alloys that titanium received any considerable publicity as an alloying agent. This

[1]Tyler, Paul M., "Supply and Demand for Steelmaking Alloys." Am. Inst. Min. and Met. Engrs., Contrib. No. 49, June, 1933, p. 10.

[2]Comstock, George F., "Titanium in Gray Cast Iron." *The Iron Age*, Vol. 131, No. 22, June 1, 1933, pp. 857-859 and adv. p. 12; No. 23, June 8, 1933, pp. 897-900.
Comstock, George F., "Titanium in Cast Iron." *Metal Progress*, Vol. 24, No. 2, August, 1933, p. 44.

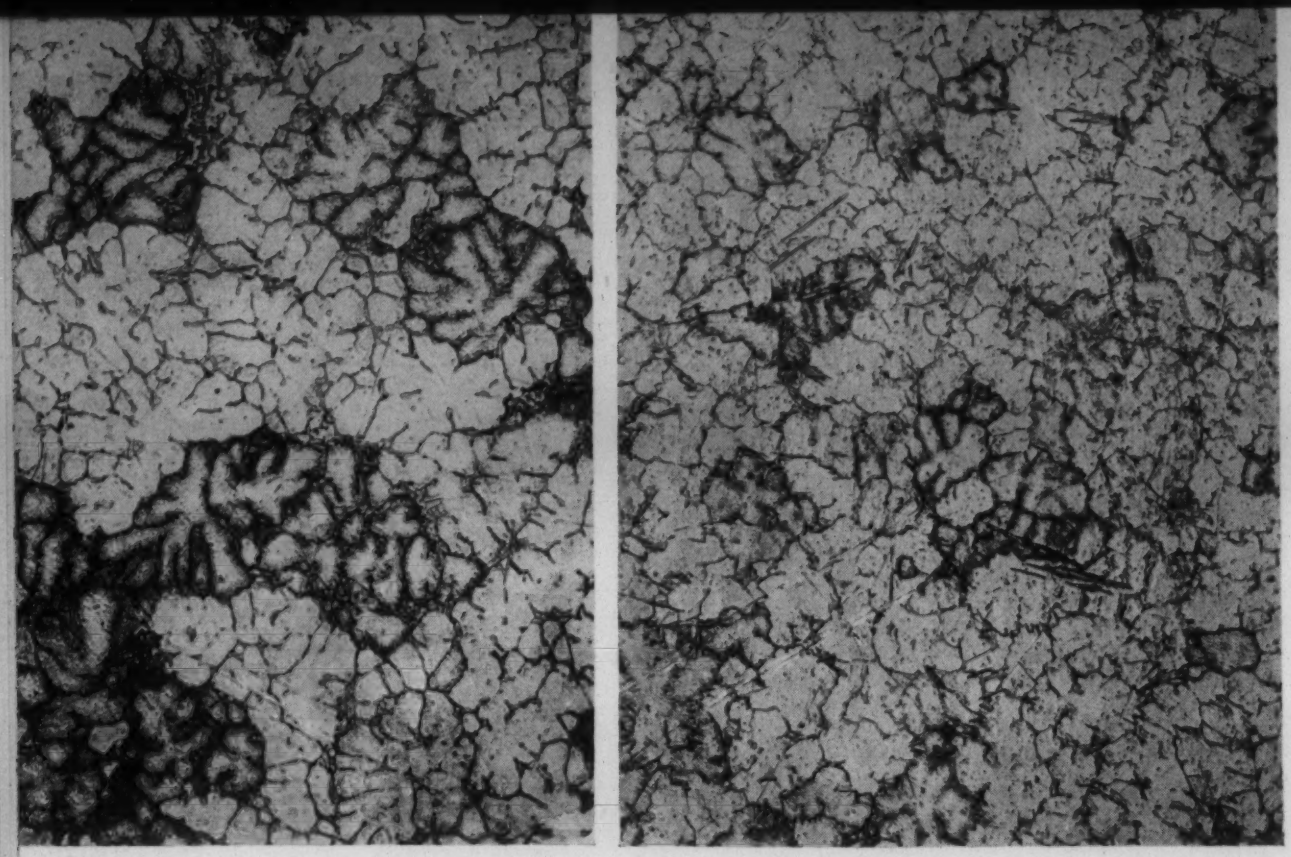

Fig. 4.—Effect of Titanium on Aluminum Alloys with About 8 per cent Copper. (a) (Left) Without Ti. Tensile Strength 17,000 lb. per sq. in. Etched with Dilute Nitric and Hydrofluoric Acid. 50 Diameters. (b) Treated with 2½ per cent Webbite so as to Contain 0.15 per cent Ti. Tensile Strength 22,500 lbs. Etched with Dilute Nitric and Hydrofluoric Acid. 50 Diameters.

platinum-like alloy of nickel with cobalt and iron contains only 2.5 per cent titanium, but it appeared[3] that the constituent responsible for age-hardening was a titanium compound, Fe_3Ti. The age-hardening effect of titanium on austenitic steels was promptly investigated and much discussed.

Reviewing this series of developments, we find that in 1931 it was proved in Germany that a very marked precipitation hardening could be obtained in silicon steels containing titanium. This tended to be accompanied by a coarsening of grain, but the latter feature could be obviated by suitable additions of nickel. Later experiments indicated that titanium can be used as a hardener with particular advantage in the case of nickel and nickel-chromium steels. To plain carbon structural steels, on the other hand, additions up to 0.4 per cent Ti with 0.1 to 1.25 per cent C seemed to improve yield point and tensile strength considerably without seriously affecting elongation or reduction of area. Moreover, similar additions to mild chromium steels (0.15 to 0.7 per cent Cr) with or without 3.5 per cent nickel, have no effect on mechanical properties,[4] and in no case could precipitation hardening be developed by heat treatment. This shows a sizable amount of work on the age hardening characteristics, but very little has followed as yet in the way of commercial developments.

Research on the use of titanium in cast copper and in copper-base alloys proceeds in promising fashion. High strength without undue loss of conductivity are obtainable by alloy additions up to about 1 per cent Ti followed by suitable heat treatment. Descriptions of certain of these effects will be found in the footnote references.[6]

New Use is for Carbide Control

The growing use of titanium as an alloying element, for the present at least, is attributable to its value for carbide control. Titanium in alloy steels of certain types effectually locks up the carbon so as to prevent it from combining with other elements and consequently robbing the adjacent matrix of one or more essential constituents. British and German patent applications in 1933 covered the employment of titanium in rustless steels to inhibit intergranular corrosion, and the use of titanium for this purpose was adequately discussed in an American paper.[5] From the Union Carbide and Carbon Research Laboratories came evidence that marked benefits are obtained by the addition of titanium in definitely limited proportions (in a ratio of 5 to 7 times the percentage of carbon) to plain high-chromium steels. Instead of the hardening effect resulting normally from the presence of chromium and carbon, steels so treated are characterized by the facility with which they may be hot-worked, their relative freedom from air-hardening, and their ductility and softness in the as-rolled condition.

A new high-speed steel utilizes titanium (1 to 2.5 per cent) instead of vanadium as a stabilizer. Thermionic cathodes of nickel or cobalt wire are often treated with titanium and this versatile element has other minor uses that doubtless are important in their respective fields but negligible from the standpoint of quantity consumption. In welding rods titanium is often present as a slag-forming agent, but for this purpose it is ordinarily the dioxide rather than the metal or alloy that is added.

The earlier literature of titanium is replete with statements as to nitrogen removal. A natural inference was that additions of the element would have the same effect on nitrogen as upon oxygen, but the difference lies in the nature of the products formed. The dioxide formed by the union of titanium and oxygen is insoluble in steel and readily removable, but titanium nitride is highly metallic and consequently is not eliminated so easily. It has even been suggested that titanium might be usefully employed for causing nitrogen absorption in the nitriding steels. However, titanium is claimed to have somewhat the same influence on nitrogen in steel as manganese has on sulphur, transforming it from combination with iron to a less harmful form.

It is reasonable to assume that the use of titanium in metallurgy is on a firmer footing then ever before. It took a dozen decades to get off to a good start, but a poor beginning proverbially leads to a good ending, and titanium takes rank as one of the coming "new metals."

(To be concluded)

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[3] Austin, C. R., and Halliwell, G. P., "Some Developments in "High Temperature Alloys in the Nickel-Cobalt-Iron System." *Trans.* Am. Inst. Min. and Met. Engrs., Vol. 99, Inst. Metals Div., 1932, p. 78.

[4] Arend, J., and Lobe, M., "Effect of Adding Small Quantities of Titanium to Structural Steels." *Stahl u. Eisen,* Vol. 53, 1933, pp. 604-6.

[5] Bain, E. C., Aborn, R. H., and Rutherford, J. J. B., "Prevention of Intergranular Corrosion in Austenitic Stainless Steels." *Trans.* Amer. Soc. Steel Treat., Vol. 21, 1933.

[6] F. L. Hensel and E. I. Larsen. *Transactions,* American Institute of Mining and Metallurgical Engineers, Vol. 99, 1932, page 55.
E. E. Schumacher and W. C. Ellis. *Metals & Alloys,* Vol. 2, Sept. 1931, page 111.
W. Kroll. *Zeitschrift für Metallkunde,* Vol. 23, Jan. 1931, pages 33-34.

Electrodeposition of Iron for Wearing and Bearing Metal

By DAVID R. KELLOGG*

SINCE IRON IS NOT a decorative or rust resisting material, its deposition has been considered only from the standpoint of preparing pure metal, or depositing wearing or bearing metal. As early as 1860 iron was used for electrotyping Russian bank notes. A historical discussion of this subject would take too much space, and, due to the widely differing views of those who have worked with it, would be quite inconclusive. Much has been written on the subject and, as is usual in most electro-deposition work, no two experimenters use the same methods or materials. In general, there are the high current density and the low current density advocates, the hot and the cold bath enthusiasts, the chloride and the sulphate bath believers, and those who use mixed chloride and sulphate baths. Addition agents of numerous kinds have also been tried.

During the war, the British Army repair shops developed a method for building up worn parts of automotive machinery, aero engines, etc. This was done by the cold sulphate bath, low current density method, described with a wealth of detail in *Automotive Industries* for Aug. 26, 1920, the work having been done by B. H. Thomas. This article describes a method which has been used successfully in actual commercial work and in their hands produced something like 6,000 repaired parts with good results. In view of its practical applications, it was decided to carry on some experiments along the same lines at the Westinghouse Research Laboratories.

Solutions and Apparatus Used

The apparatus used was essentially that described in the article above mentioned except that the current used for cleaning was obtained from a ¾-k.w., 60-volt, house-lighting generator, direct connected to a 2-h.p., 870-r.p.m., 440-volt, 3-phase, type CS induction motor, while the plating current was taken from the storage batteries at any desired voltage. The anodes were made from 0.036 in. (0.92 mm) Armco iron made into cylinders 5 in. (127 mm) long by 8 in. (203 mm) in diameter with a disc of ⅛-in. (3.2 mm) Micarta, having a 2-in. (50 mm) hole in the center fitted at each end of the cylinder for stirring. The anodes were hung on a wooden rocker frame driven by a wooden connecting rod directly connected to a small reducing gear such as is sold by most of the apparatus supply firms. Three-gallon (11.4 L) stoneware crocks were used as containers.

The solution used by Thomas, namely, 75 grams of crystallized ferrous ammonium sulphate per liter, was tried, using the current density recommended by him, namely, 0.33 amp. per sq. dm. Under these conditions, the deposit on a 0.50-in. rod of cold rolled steel was smooth, bright, and adherent, standing bending and refusing to chip off even when attacked at the junction of coating and parent metal with a cold chisel. A current efficiency of about 75 per cent was obtained, the rate of deposit being about 0.0002 per hr.

Baths prepared as above had an H ion concentration of 10^{-5} and when freshly made, could be operated at two or three times the rate given by Thomas. However, they were rather uncertain in their behavior, being especially liable to oxidize when used with small pieces. In fact, the oxidation was sufficient to entirely prevent the deposition upon wires. Upon adding ferrous carbonate "mud" that was kept under water after preparation, this tendency to oxidize and hence increase in acidity, was somewhat reduced, and the baths which were worked steadily maintained an H ion concentration of 10^{-6}. Powdered charcoal was also found to help in securing a good deposit, and was used in all subsequent work. Various addition agents such as boric acid, tartaric acid, ammonium tartrate, etc., were tried in an endeavor to get a consistently smooth adherent deposit, but these always had disastrous effects.

During this period of the work, it was shown that

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Practical Uses of a Plating Process

THAT electrolytically deposited iron can be employed successfully and effectively in the repair of worn parts of machinery and for other valuable uses is established by the information contained in this article. The method of depositing the iron is described. Some of the actual applications demonstrated include:

A motor shaft bearing was purposely finished small, then plated oversize with iron and reground to proper dimensions; at the end of a severe run, the wear was inconsequential; plug and thread gages repaired; plating the throw bearing of a crank shaft, and 70 to 80 salvage jobs.

Coatings obtained by one method are very much harder than pure iron, usually about 220 Brinell.

additions of ferric iron resulted either in a hard brittle specular coating, similar to that sometimes obtained when the acidity was too high, or in no coating at all; and that satisfactory deposition did not take place until all the ferric iron had been reduced to the ferrous state. Additions of sulphuric acid to the bath until it was perfectly clear and had an acidity of 0.001 normal resulted in hard brittle coatings, usually pretty well covered with pits.

The Thomas Method Adopted

As a result of this preliminary work the procedure recommended by B. H. Thomas was adopted. After the work had been cleaned with gasoline or benzene, it was made the cathode in an alkaline bath containing about 5 per cent commercial lye and about the same amount of sodium carbonate, the exact amount being immaterial. A current density of 3 to 5 amp. per sq. in. (46 to 77 amp. per sq. dm.) was used. It was treated in this bath for 3 mins., at the end of which time it was washed in running tap water and made the anode with approximately the same current density in 20 to 30 per cent commercial sulphuric acid for an equal length of time. As a matter of fact the current in the acid cleaning bath was always adjusted more with respect to the free gassing of the anode than to the actual current density.

When for any reason the cleaning current was too low to make the work passive, cleaning was unsuccessful, the piece came from the bath with a dark color, and it was found impossible to produce a good coating on it. It was also noted that if the work were moved about during the anode cleaning, it rapidly became active, and again became passive upon cessation of the motion. When this condition was very noticeable, it was a good indication that the cleaning current was fairly close to the lower limit. With a current density of 5 amp. per sq. in. (77 amp. per sq. dm.) this effect was not so noticeable. After cleaning in this manner, the work was well washed and immediately transferred to the plating bath. With the plating solutions at room temperature, it was found entirely feasible to deposit at the rate of 1 amp. per sq. dm., which is three times the rate given by Thomas.

This process gave smooth, tough, adherent coats which, when deposited on a carefully ground rod 0.485 in. (118.8 mm.) in diameter and then ground to a thickness of 0.0010 in., (0.0259 mm.) could be pressed through a hole in 1-in. cold rolled steel 0.0005 in. (0.0127 mm.) smaller than the finished size of the rod, and then pressed back again with no signs of stripping. These test rods could be bent and variously mishandled with no damage to the coat.

Experiment With a Motor Shaft Bearing

A motor shaft having bearings of 5/8 in. (15.8 mm.) diameter by 1.5 in. (38.1 mm.) long was purposely finished 0.002 in., (0.0508 mm.) small in diameter, plated oversize and then reground to proper dimensions. This shaft was then assembled and run in bronze bearings for 1000 hr. with a load of 50 lb. per sq. in. (3.5 kg. per sq. cm.) projected area, using a short stiff belt with a clipper joint in order to give a pounding effect as well as friction. At the end of the run it was found that the wear was 0.0002 in. (0.005 mm. on the diameter), which is just a trifle less than the original material shows in factory life tests.

Plug and thread gauges have been repaired by this means and have given good satisfaction although they are not as hard as heat-treated tool steel. It is of course possible to carburize such pieces and then they would compare favorably with the original gauges.

Another interesting job done by this method was on the throw bearing of a crank shaft of an experimental gasoline engine where the maximum pressure was about 650 lb. per sq. in. (45.7 kg. per sq. cm.) This was given about 100 hr. intermittent running and then 400 hr. continuous running. During the first period two "freeze ups" occurred, due to experiments being made with various bearing metals, and yet when the engine was taken down for inspection the bearing surfaces of the shaft were in perfect condition and showed a wear of 0.00025 in. Many press fits and running fits have been repaired for shop use and no case of failure has yet occurred. Coatings obtained by this method are very much harder than pure iron, usually about 220 Brinell.

The relatively dilute solution, worked at low current densities and at room temperatures, produced a coating which was very satisfactory for most purposes, but was somewhat hard to machine. However, the greatest draw-backs to this method were the very slow rate of deposit and the tendency of the bath to produce pitted deposits, which always resulted if the anode area was not sufficiently large in relation to the cathode area and the exposed surface of the solution.

Hot Concentrated Baths

The next line of attack was accordingly along the line of hot concentrated baths operated at high current densities. A very interesting paper by Lieut. W. A. MacFayden, appearing in the *Transactions* of the Faraday Society, Vol. X part III, page 98, gave very complete data on the use of a bath with 300 grams of ferrous ammonium sulphate per liter and worked at 50 to 70 deg. C. All of Macfadyen's work was done with stagnant solutions, but as our previous work with the cold baths had indicated the value of ferrous carbonate mud and charcoal, which necessitated stirring, we combined the two methods. The deposits obtained in this way, using current densities up to 10 amp. per sq. dm., were softer than those from the cold baths, perfectly adherent and of a beautiful velvety appearance. This procedure gave a greater increase in the rate of deposit than corresponded to the increase at current density, as the current efficiency jumped to practically 100 per cent.

When the current density was as high as 10 amp. per sq. dm., or ten times the highest value successfully employed in our cold bath, the coatings were slightly coarser grained than those obtained at lower current densities. The major portion of the work done with the hot concentrated bath has been at 6.7 amp. per sq. dm. Coatings deposited in this way resist bending, cold chisel and press fits. The thickness which may be deposited is far in excess of that required for any repair work. One piece had 0.22 in. (5.6 mm.) deposited in a discontinuous manner, the test rod being plated whenever a bath and the time necessary for electrolytic cleaning were available. As the deposition progressed, trees tended to form, but these could readily be removed and the work of deposition continued. While the cold bath coatings are rather hard to work in the lathe, those from the hot bath machine beautifully with a tool having a small rake and clearance such as is used for cast iron.

Plating on Cast Iron

Another development of this work is in plating on cast iron. When cast iron is put through the electro-

lytic cleaning process, it emerges from the acid with a coating of graphite. The writer was of the opinion that it would be useless to attempt to plate anything so covered with slime and hence recourse was had to a preliminary coppering, produced by first giving the piece a dip in arsenic chloride solution and then copper plating from an acid copper sulphate bath. Iron coatings deposited upon this base were fairly adherent but not much to boast of.

One day J. D. Alley, who was carrying on this work, cleaned a cast iron rod in the usual manner and then placed it, all covered with graphite as it was, in the plating bath. Greatly to our surprise and delight the coating was an entire success. Carefully ground test rods of cast iron were plated with a coating which, after grinding to 0.376 in. (9.55 mm.), left 0.001 in. (0.0254 mm.) of coating and others were left after grinding with 0.010 in. (0.254 mm.) of coating on a side. These were pressed through a hole in 1-in. cold rolled steel which was 0.0005 in. (0.0127 mm.) smaller than the finished size of the test piece, then pressed back again, showing absolutely no tendency to chip or strip off. While it is usually cheaper to scrap standard cast iron parts accidentally machined undersize, there are many cases where replacement of special parts would mean making new patterns and then casting, and where the time and expense saved would amply pay for the necessary work of reclamation.

Effect of Impurities

An interesting point in connection with this work is the effect of impurities in the bath on the coating obtained. In connection with some experiments on the possibility of revolving the work in a horizontal position, as, for instance, plating a large shaft in place, a wooden tank was used for plating a steel cone. Many attempts to secure a good coating failed although we felt sure the rate of stirring and other obvious factors were correct. It was then noted that once in a while a coating produced in the regular stone-ware jars was not satisfactory. It was also noted that these imperfect coats came when the solution was high enough in the jars to cause splashing of the solution on the wooden cross-piece which held the test rod. Accordingly, this effect was carried to the limit by putting into a perfect bath a couple of handfuls of shavings.

The effect was disastrous. Even after the shavings had been removed, this bath gave deposits which were hard, brittle, specular and non-adherent. Additions of charcoal improved matters somewhat, but did not completely repair the damage. The damage is not due entirely to increase of acidity as the H ion concentration after the addition of charcoal was changed from 7×10^{-5} to 2×10^{-6}, which is a perfectly satisfactory value, giving good deposits under normal conditions. This experiment with shavings has shown why we were unable to get a satisfactory coat on the steel cone above mentioned. It indicates the inadvisability of using wooden tanks unless lined with some protective coating. It may be of interest to note in connection with the subject of impurities that for several months all our work has been done with commercial grades of chemicals, no chemically pure material having been used.

In connection with all this work a rather close watch of the acidity has been maintained, using a simple H ion concentration apparatus assembled in the laboratory from stock material. It now appears, however, that this is unnecessary in practice as the hot concentrated bath results in such complete anode corrosion that oxidation is practically negligible. The addition of small amounts of ferrous carbonate mud is still practiced, but the amount used up is very small. These baths may be left for weeks at a time when not in use without any serious oxidation. They have also been worked for weeks at a time, most of the work being done during the daytime, as the rapid rate of deposit —.004 in. to .005 in. (0.102 to 0.127 mm.) per hr.— makes it possible to do almost any job in one working day.

Many Salvage Jobs

In addition to a very large number of test pieces, between 70 to 80 salvage jobs have been done for the shop, running all the way from the badly scored end of a 1/20-h.p. motor to an experimental aeroplane propeller hub. For the electrolytic cleaning of the larger pieces we used a 300 amp. arc welding M-G set, with the series field coils short-circuited and with a potentiometer rheostat across 110 volt dc. for the shunt field. This arrangement together with the regular field rheostat gave a fine adjustment of current, so that the set may be used for small work, or for work requiring up to 450 amp. for cleaning.

Great credit for the careful ingenious work in connection with these experiments is due to Leon McCulloch, T. P. Thomas, and J. D. Alley, who handled the experimental part of the work, as well as contributed many valuable ideas to its development.

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The Protection of Radium Workers

By HERBERT R. ISENBURGER*

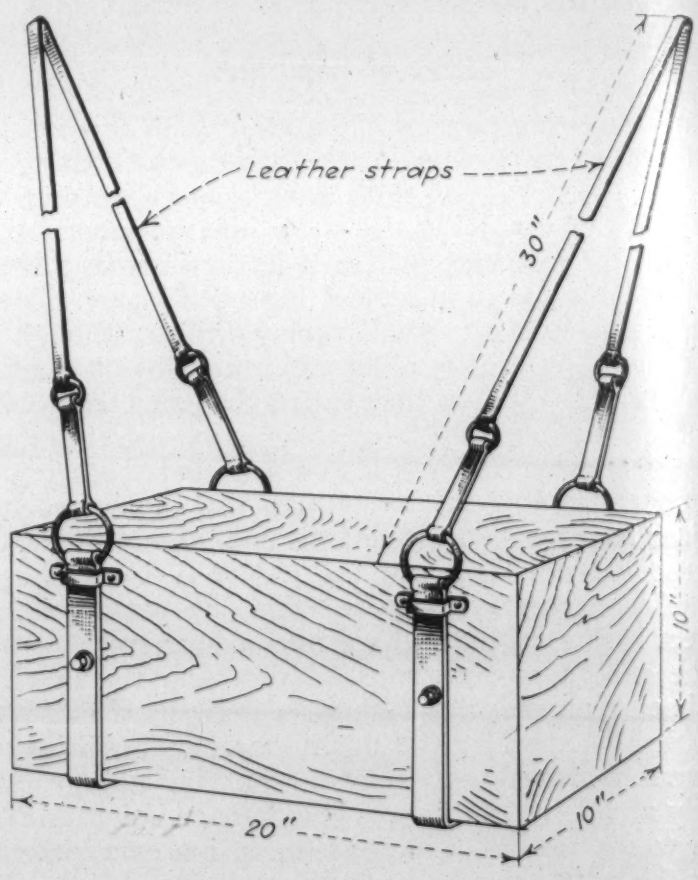
A GOOD DEAL has been published in recent years on the application of radium or other radioactive materials to the problems of non-destructive testing of engineering materials. The value of this work has been well-recognized. Gamma-ray inspection is useful whenever X-ray examination ceases to be practicable. Because its application seems to be a very simple matter, a great deal of work has been done by inexperienced people. And yet the handling of radium requires much greater care and many more precautions than that required when using X-ray equipment.

While we still do not know everything about X-rays, we, at least, have established certain standard rules for working with this radiation. Up to very recently this has not been possible for gamma-radiation. Even today a lot remains to be learned about the ultimate reaction from frequent exposure to radium and other radioactive materials, like radon, mesothorium, and the like.

In a recent paper† on this subject, some well-known English physicists describe the results of research work done at the National Physical Laboratory at Teddington. They establish recommendations for radium workers which will furnish the basis for the next International Congress. While their work has been done with medical application in mind, most of the recommendations should be observed in industrial gamma-ray work. As a matter of fact, in our field, we are dealing with much larger quantities of radium and often have to work under much worse conditions than the routine medical attendant. Our rules, therefore, ought to be stricter than the requirements for medical work.

We have known, and it has been confirmed by the present investigations, that a certain amount of gamma-rays will penetrate through the presently-used containers in which the radium is carried. This depends upon the quantity of radium or the strength of the radon. The British investigators give some excellent advice on how to make up the radium capsules and lead-lined containers. The necessary thickness of lead to protect the worker who has to carry the radium is given for various quantities in column No. 4 of the accompanying Table.

While the results of gamma-ray exposure are cumulative, they will wear off after a certain time, if the worker does not handle radioactive material in the meantime. Otherwise, every single exposure will add to the destruction of blood cells, unless special precautions can be taken. A tolerance distance has been established for workers who do this kind of work occasionally and another one for continuous operation with radium. We restate these distances in columns Nos. 2 and 3 of the Table. It is quite obvious that the worker cannot keep out of this range when planting the radium seed and when it is taken off again. During these two operations he must expose himself to gamma-rays. He, therefore, should have everything prepared very thoroughly so that he can fulfill his duty as quickly as possible. Otherwise, he must observe the specified tolerance limits.



Proposed Container, Lead-Lined, for Radium

In industrial gamma-radiography we deal with very long exposures which last for hours. Whenever possible, this work is done at night when none of the personnel is about. In routine operations, it happens frequently that the work must be carried on by day and night. In such cases the area within the tolerance limits should be screened off so that nobody can enter the exposure zone. If, on account of space limitations, the tolerance distance must be reduced, a lead protection can be employed to screen off a smaller area. The thickness of lead required depends upon the quantity

(Concluded on page 105)

* St. John X-Ray Service, Inc., 30-20 Thomson Avenue, Long Island City, N. Y.

†Kaye, Bell and Binks; *British Journal of Radiology*, Vol. 8, No. 85, 1935. Pages 6-26.

ENGINEERING PROPERTIES OF "K MONEL" METAL

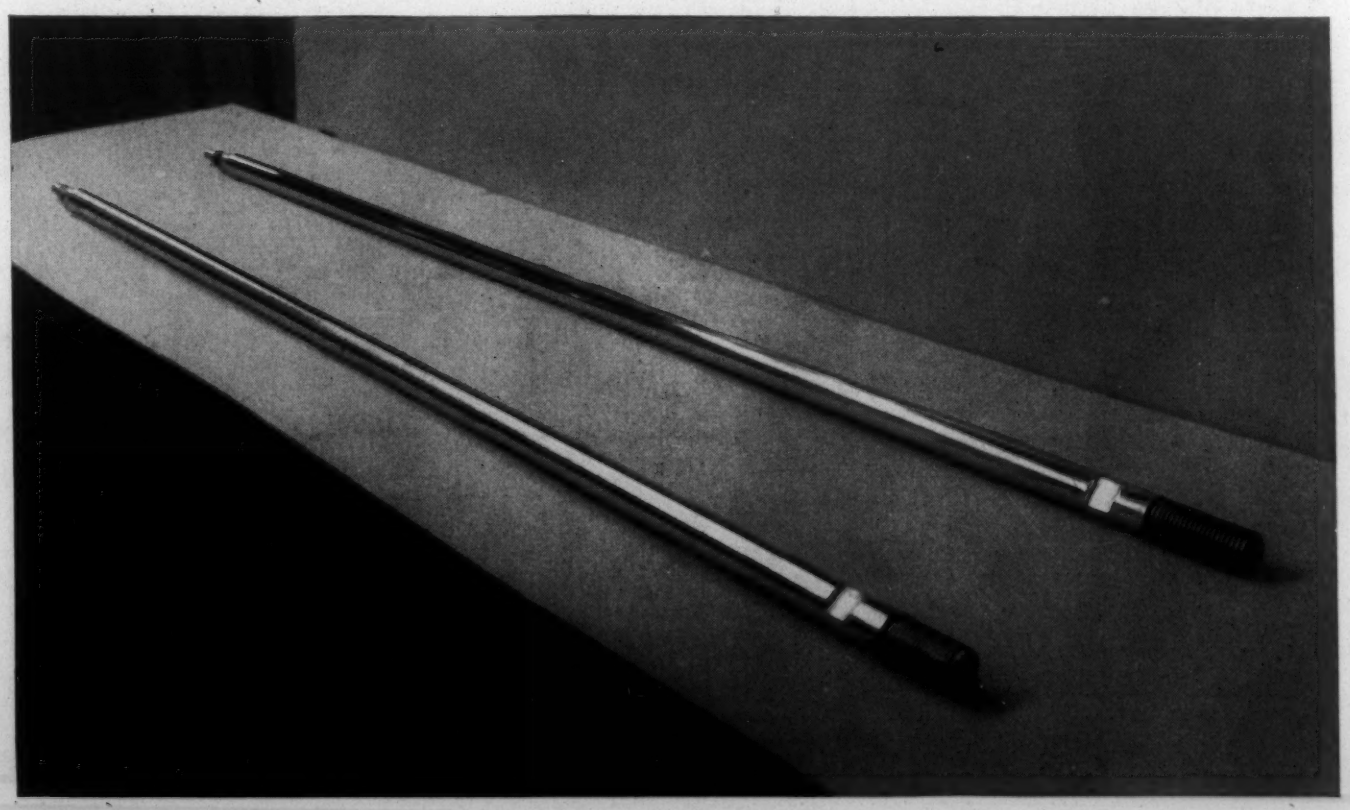
An Extended Abstract*

A DISCUSSION, which virtually amounts to a small symposium, is presented this month to the readers of METALS & ALLOYS on the subject of the copper-nickel-aluminum alloys. This article, and the one on other pages by Crampton and Croft on the wrought alloys, presents from different angles various phases of these interesting compositions and presents for the first time in considerable detail the results of extended researches.

"K MONEL" IS A CORROSION resistant, non-ferrous alloy of nickel, copper and aluminum. It is produced by the addition of a small amount of aluminum to Monel metal. The interesting and important advantage of this alloy is the fact that it may be hardened by heat treatment. An analysis, typical of present production, might show:

Nickel	63.32	Manganese	0.50
Copper	30.84	Carbon	0.16
Aluminum	3.45	Silicon	0.20
Iron	1.50	Sulphur	0.005

This composition retains the excellent corrosion resistance characteristic of Monel metal with the added advantage of increased strength (and hardness) after heat treatment. Soft K Monel, of a hardness around 140 to 150 Brinell, responds to heat treatment that will result in raising the hardness to 300 Brinell or even above this value. K Monel affords strength ordinarily found only in heat-treated alloy steels, and not offered by other corrosion resistant alloys available at moderate price levels.



Pump Rod (1¼ in. diameter and 6 ft. long) of K Monel Metal for Reciprocating Pump in Marine Service.

Mechanical and Other Properties

This alloy in its hardest grade has a proportional limit in excess of 100,000 lb. per sq. in., a tensile strength in excess of 160,000 lb. per sq. in. with elongation (in 2 in.) over 15 per cent, combined with the corrosion resistance of Monel metal. Tempered to lower hardness, the ductility is greater and the strength less. The properties and hardness are given in Table III and Fig. 1.

Material, which has been heat treated to produce maximum hardness, may be heated to about 1050 deg. F., followed by quenching or slow cooling without appreciably affecting the original properties. If heated above 1050 deg. F. and quenched, the properties will be decreased somewhat.

The elastic moduli of this alloy are the same as those of Monel metal:

Modulus of elasticity in tension	26,000,000
Modulus in torsion	9,500,000

Strength at Elevated Temperatures

Table IV gives the strength at elevated temperatures determined by short time tensile tests. These values

* Of a technical bulletin to be issued soon by the International Nickel Co., Inc., New York, by C. A. Crawford and G. F. Geiger, development and research department and Dr. W. A. Mudge, works metallurgist.

are for rods in the hot rolled, annealed (Hardness Grade A) and cold drawn, fully hardened (Hardness Grade D) conditions.

Spring Properties

K Monel is useful as a spring in large sizes which cannot readily be fabricated wholly by cold processes.

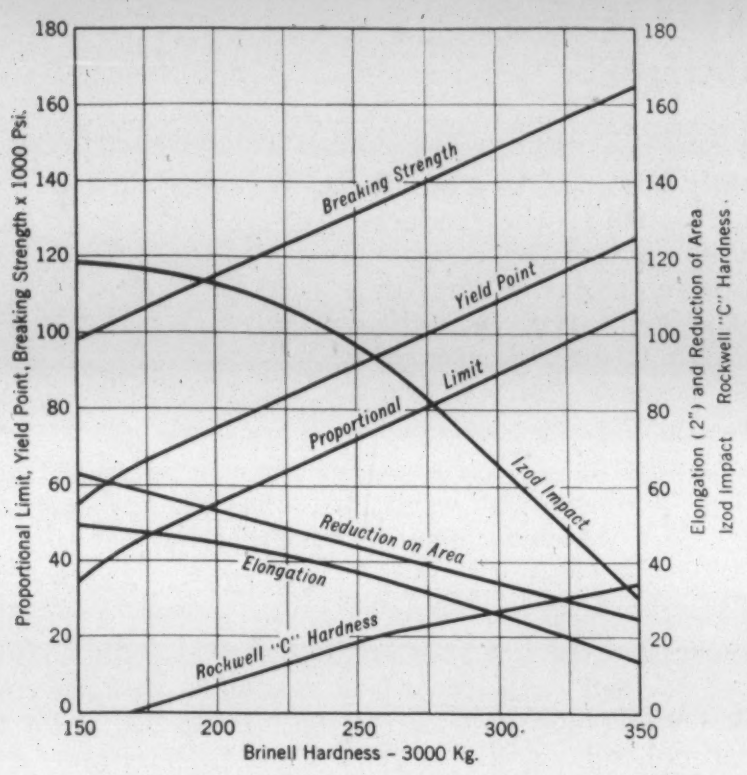


Fig. 1. Tensile and Impact Properties of K Monel and Their Relation to Brinell Hardness. (W. A. Mudge)

The springs can be made from soft rod or formed hot and the spring temper developed by heat treatment. In this case the proportional limit and breaking strength will be Grade C or D, depending upon the size of the

Table I.—Chemical Composition in Per Cent

Nickel (min.)	Copper (min.)	Aluminum (max.)	Carbon (max.)	Other Metals (max.)
63.0	25.0	5.0	0.20	5.0

spring and the amount of cold work developed by the coiling. Breaking strength of 175,000 to 200,000 lb. per sq. in. is developed by combining 75 per cent cold drawing with heat treatment and cannot be reached in

Table II.—Physical Constants

Density		8.58
Weight, lb. per cu. in.		0.31
Melting point		2400 to 2460° F. 1315 to 1350° C.
Specific heat (20-400 deg. C.)		0.127
Heat expansion		
(25-100 deg. C.)		0.000014
(25-300 deg. C.)		0.000015
(25-600 deg. C.)		0.000016
Heat conductivity (0-100 deg. C.), c.g.s.		0.06
Electrical resistivity (at 0 deg. Cent.)		
microhm centimeters	Hardness Grade A	62.8
	Hardness Grade C	62.0
	Hardness Grade D	61.9
ohm per mil-foot	Hardness Grade A	378.
	Hardness Grade C	373.
	Hardness Grade D	367.
Co-efficient of electrical resistivity, per deg. C.		0.00019
Magnetic transformation		Below —112° F. — 79° C.

springs made by hot forming. This grade retains its properties at temperatures up to 400 deg. F. The torsional proportional limit is about 80,000 lb. per sq. in.

Endurance Limit and Impact

The endurance limit of K Monel in the fully heat-treated condition, determined on flat strip subjected to alternate back and forth bending as a flat spring, is approximately 36,500 lb. per sq. in. In the soft condition the endurance limit is very much lower. Comparative values from tests in the same apparatus are shown in Table V.

Like Monel metal, the endurance limit under non-corrosive conditions is lower than found in most carbon and alloy steels. On the other hand, where corrosion enters, the endurance limit of the steels is markedly

Table III.—Mechanical Properties

Hardness Grade	Tensile Strength, Lb. per sq. in.	Yield Strength at 0.5 per cent Elong., Lb. per sq. in.	Proportional Limit, Lb. per sq. in.	Elongation per cent in 2 in.	Reducation of Area, per cent	Brinell Hardness Range, 3000 Kg.
A	120,000 max.	80,000 max.	60,000 max.	40 min.	50 min.	Softer than 225
B	120,000 min. 140,000 max.	80,000 min. 100,000 max.	60,000 min. 80,000 max.	30 min.	35 min.	225 to 275
C	140,000 min. 160,000 max.	100,000 min. 120,000 max.	80,000 min. 100,000 max.	20 min.	25 min.	275 to 325
D	160,000 min.	120,000 min.	100,000 min.	15 min.	20 min.	Harder than 325

Notes: A is the softest grade obtained by a softening heat treatment. Parts made from Grade A will in most cases be hardened by heat treatment after fabrication.

All Grade A is quenched off the hot rolling mill and shipped in that condition.

Grades B and C are intermediate. The minimum values of strength and ductility are to be considered typical in each case and the producer will aim to deliver the minimum strength values for the grade. The upper limits are set forth only as the boundary of the next higher grade. Grade C is the strongest grade that can be machined to advantage. Grade C will be specified in cases where parts are to be machined and used without further heat treatment.

Grade D is the cold worked and fully heat-treated alloy in its hardest and strongest condition. Grade D can be machined only with difficulty, but can be finished by grinding.

reduced, while that of K Monel is much less affected. Where corrosion is at all severe, the endurance limit of the steel will be actually lower than that of K Monel.

The impact resistance decreases with increasing hardness. In the soft condition, it has the same impact value as regular hot rolled Monel metal. In the most commonly used hardness, Grade C, the impact values compare favorably with heat-treated, low alloy steels.

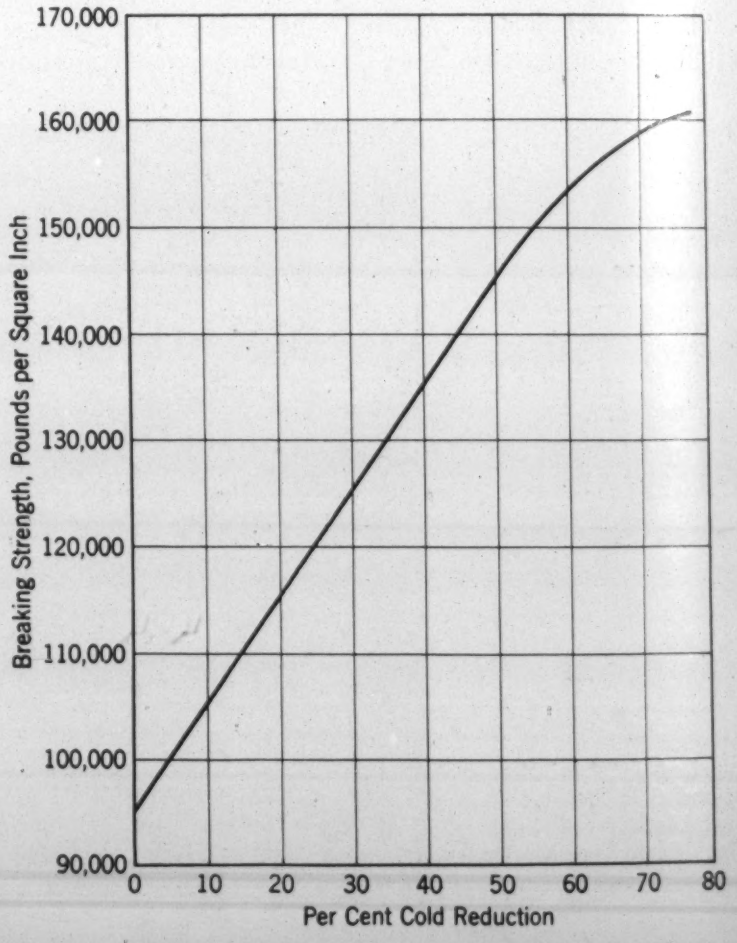


Fig. 2. Effect of Cold Work on K Monel Wire without Supplementary Heat Treatment.

Magnetic Characteristics

K Monel is non-magnetic under ordinary working conditions and remains so at subnormal temperatures.

This non-magnetic quality is particularly valuable in instrument and radio work. For example, on airplanes, non-magnetic corrosion resistant wire of high strength is needed. Many non-magnetic alloys which depend on cold working for the development of high tensile strength become magnetic with the cold working. The non-magnetic quality of K Monel is retained in the fully hardened condition.

Table IV.—Properties of the Heat-Treated Alloy

Hot Rolled Rod—Annealed (Hardness Grade A)

Temp. deg. F.	B. S. lb. per sq. in.	Y. P. lb. per sq. in.	P. L. lb. per sq. in.	Elong. per cent in 2 in.	R. A. per cent in 2 in.
75	97,000	42,500		49.0	63.0
200	95,000	42,000		50.0	63.0
400	94,000	40,000		53.0	62.0
600	90,500	37,000		56.5	62.0
800	83,500	37,500		53.5	54.0
1000	75,500	33,500		31.5	28.5

Cold Drawn Rod—Heat Treated Hard (Hardness Grade D)

Temp. deg. F.	B. S. lb. per sq. in.	Y. P. lb. per sq. in.	P. L. lb. per sq. in.	Elong. per cent in 2 in.	R. A. per cent in 2 in.
75	165,000	125,000	105,000	21.0	38.9
200	163,000	124,000	104,000	21.0	37.0
400	156,000	118,000	100,000	20.0	35.0
600	147,600	108,600	84,100	19.5	32.8
800	125,000	106,000	81,300	18.5	29.8
1000	124,600	102,800	70,500	9.5	9.8

Hot and Cold Working

The heating of K Monel for hot working should be carried out in a furnace of such design that the flame does not impinge directly on the metal. The fuel should be free from sulphur and a reducing atmosphere should be maintained.

The furnace may be operated at 2200 to 2250 deg. F. However, the metal should never be allowed to reach this figure, but should be removed on a rising temperature between 2000 and 2175 deg. F. Hot working should not be continued below 1700 deg. F. If further hot work is required, reheat the metal. It should not be placed in a cold furnace and brought up to temperature with the furnace, but should be charged into the hot furnace.

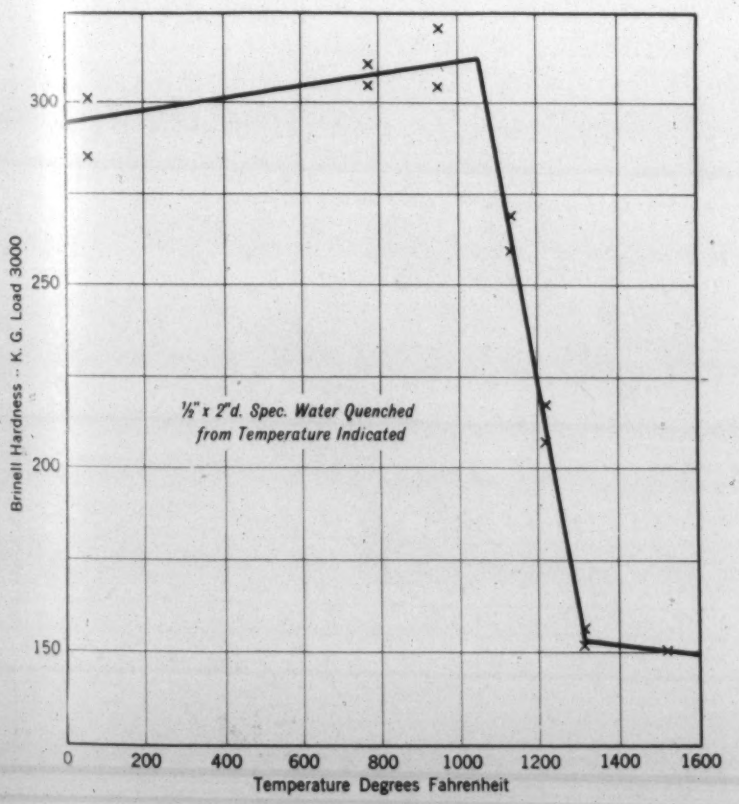


Fig. 3. Effect of Quenching from Temperature on Hardness of K Monel. Partial softening between 1060 and 1300 deg. F. Complete softening at 1450 deg. F. (Data are from P. R. Kosting.)

The finishing temperature of hot worked material should be above 1700 deg. F. and the metal quenched therefrom. This practice is necessary when the material is later to be re-hot worked or to be given the hardening heat treatment. The alcohol-water quench may be used to facilitate pickling after hot working.

The cold working properties are similar to those of Monel metal. The effect of cold work on the alloy is shown in Fig. 2. As cold drawn and stress relief annealed (at 525 deg. F.) the breaking strength of rod will be 120,000 to 140,000 lb. per sq. in. For strength of 160,000 lb. per sq. in. or more, the material must be heat treated.

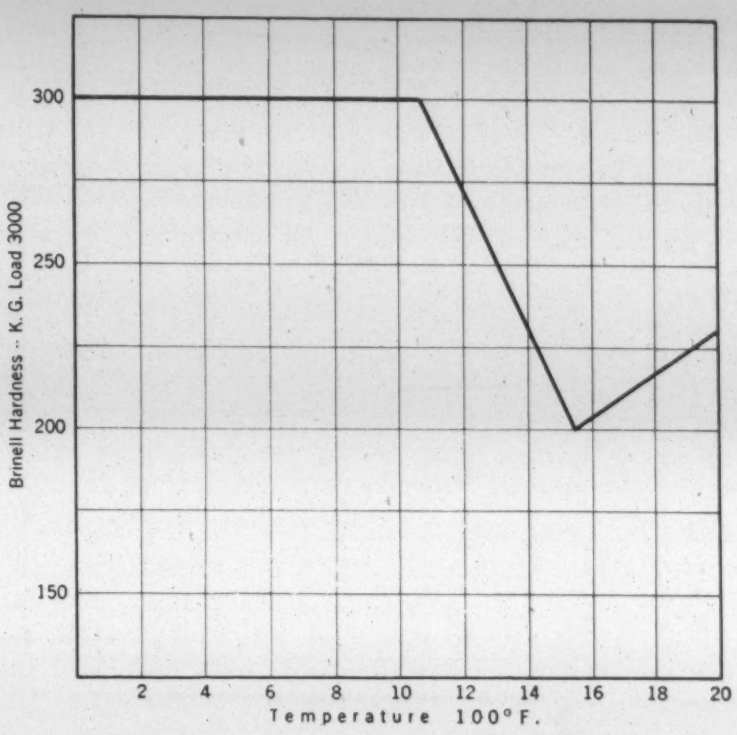


Fig. 4. Partial Softening of K Monel by Air Cooling from Temperature. Hard K Monel is softened to the Brinell hardness read from the graph by air cooling from the temperatures plotted. (W. A. Mudge)

Rod, strip and wire are produced from hot rolled material by annealing, pickling and cold working. The hardness of strip as full hard, cold rolled will be about 45 Shore (Universal) Scleroscope and may be raised to 55 or 60 Scleroscope by heat treatment.

Wire is cold drawn through chromium plated steel, tungsten carbide or diamond dies, depending upon the finished size. The percentage of cold reduction will depend upon the desired properties. For heavily cold worked material, such as spring wire, the heat treating (hardening) temperature should be decreased to 950 to 1000 deg. F. in order not to anneal out the effect of cold work. As cold drawn (75% reduction of cross section area) and stress relief annealed (525 deg. F.), the breaking strength will be 150,000 to 175,000 lb. per sq. in. For strength of 175,000 to 200,000 lb. per sq. in. the material must be heat treated.

Table V.—Table of Endurance Limits

(On basis of 100,000,000 cycles alternating flexure)

Material	Temper	Tensile B. S. Lb. per sq. in.	Endurance Limit Lb. per sq. in.
Aluminum 2SH.....	Hard Worked	.....	9,000
Aluminum 3SH.....	Hard Worked	.....	11,000
Brass	Soft	.....	14,000
	10 B&S Nos. Hard	.....	21,500
Phosphor Bronze....	Soft	59,700	20,000
	10 B&S Nos. Hard	124,800	24,500
Monel Metal.....	Soft	65,000	22,500
	Full Hard	119,400	34,500
K Monel.....	Soft, Grade A	83,000	26,000
	Hard, Grade C	153,000	36,500

Heat Treatment

K Monel may be softened (annealed) by heating to a temperature between 1400 and 1500 deg. F., pref-

erably 1450 deg. F., for a sufficient time to insure heating throughout, followed by quenching in a suitable medium, such as water or oil. Quenching is essential; the alloy is not soft on air cooling unless the cross section is small. Open heating in a sulphur-free reducing atmosphere is preferred to using a box because of the greater ease of quenching. Water is most com-

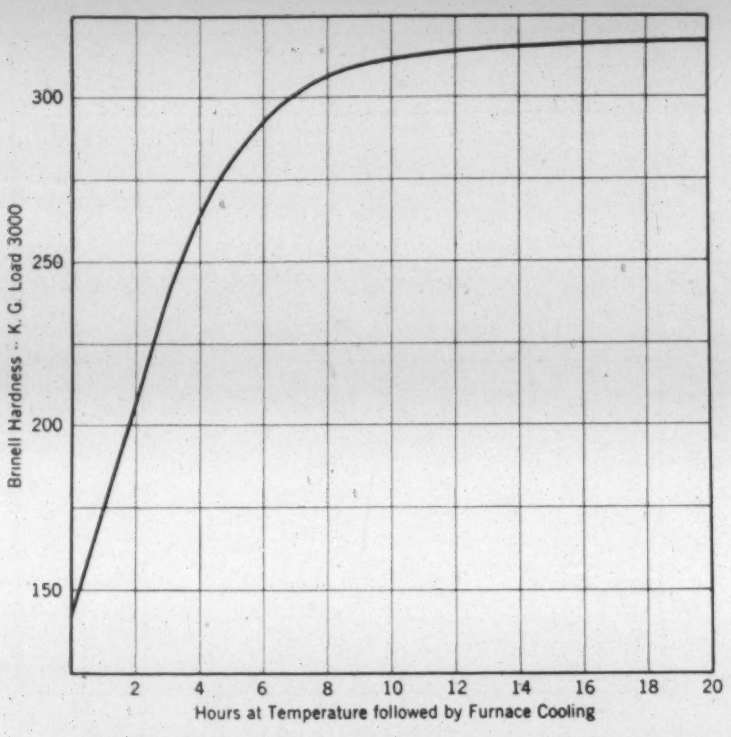


Fig. 5. Hardening Curve for K Monel—Effect of time at Temperature (1100 deg. F.) on Brinell hardness. (W. A. Mudge)

monly used as the quenching medium, and it is good practice to add 1 to 2 per cent of denatured alcohol to the water quench. The alcohol will practically reduce the film of oxide on the metal, resulting in a much more rapid and uniform pickle.

Fig. 3 shows the quenching of specimens of K Monel from different temperature levels. The hardness values fall on two lines which intersect in the neighborhood of 1060 deg. F. Complete softening is gained if the quenching temperature is above 1400 deg. F.

The useful application of partial softening by quenching from intermediate temperatures between 1060 deg. F. and 1300 deg. F. is problematical, because the rate of change with temperature is so high (of the order of 0.6 BHN per deg. F.).

Rapid air cooling effects a mild quench and results in partial softening. That is, a piece of the alloy, rapidly air cooled from 1100 deg. F., will not be as hard as a piece, furnace cooled from the same temperature. This has been used in a practical way to partially soften forgings made from K Monel without resorting to the double heat treatment. The plot (Fig. 4) indicates the resulting hardness after air cooling from temperatures in this range.

Hardening

Maximum hardening by heat treatment is accomplished by slowly cooling from 1075 to 1100 deg. F.

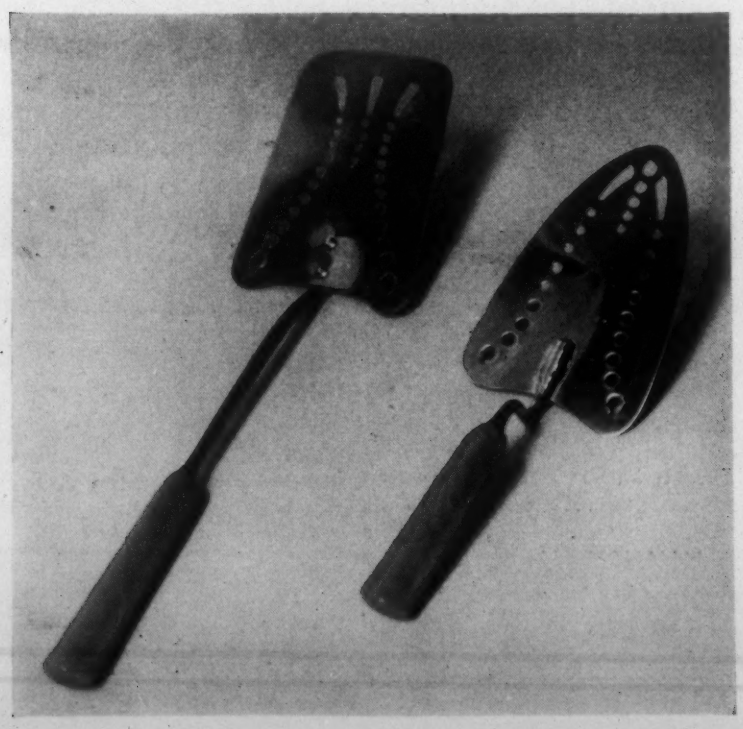
Table VI.—Impact Values

Hardness Grades	Standard Izod Test, Ft. Lb.	Tensile Charpy Test * Ft. Lb. Trans.	Long.
A	100-120	56	81
B	80-100	..	..
C	59- 68	44	53
D	44- 48	..	..

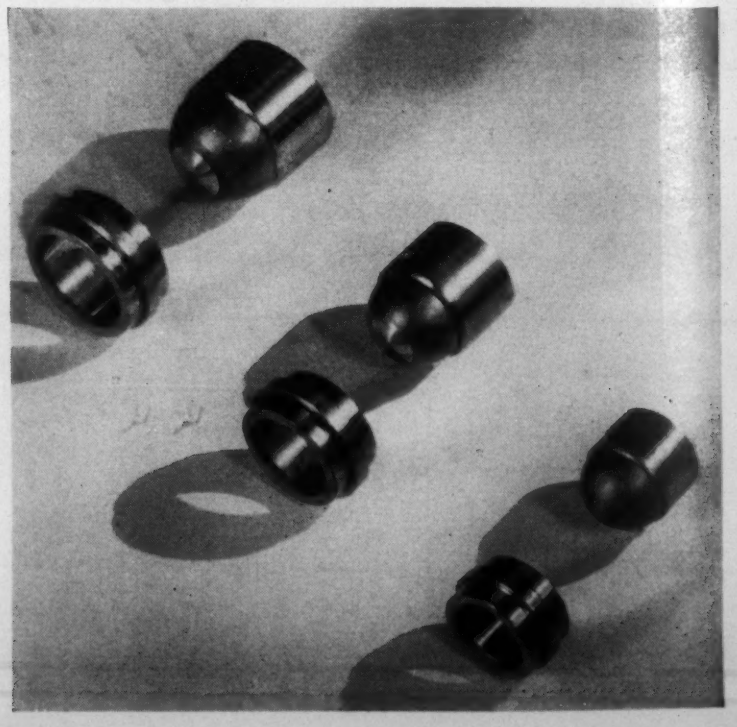
* Tensile impact data from Dr. P. R. Kosting, based on test method and specimen used at the Watertown Arsenal.

Higher temperatures result in lower hardness. The hardening is a time-temperature effect, and the hardness increases with increased time of holding at temperature up to 6 or 8 hr. Ordinarily 6 hr. is ample holding time, and little is gained by holding longer than 8 hr. See Fig. 5. The temperature at which the heat treatment is carried out should be carefully controlled, as this will govern the level of hardness resulting.

Maximum hardness due to heat treatment alone, starting with soft metal, is in the neighborhood of 300 Brinell, but if the hardness of soft material is raised by cold working, then the hardness resulting from subsequent heat treatment will be super-imposed. Thus, cold worked metal with a hardness of approximately 250 Brinell can be increased by heat treatment to 350 to 400 Brinell.



Blades in Kitchenware of K Monel.



Drop and Seat Valves (1¼ in. diameter, 45 deg. seat) of K Monel for Oil Well Service

It has been observed, however, that if the K alloy, hardened by cold work, plus heat treatment, be exposed to heat-treating temperatures (about 1100 deg. F.) for long periods of time, the hardness due to cold work will be eliminated and the Brinell values will fall to approximately 300; that is, the value obtainable by heat treatment alone. Intermediate hardness and cor-

responding machinability can be obtained by following the middle portion of the curve on Fig. 4.

Summary of Heat Treatment

Soft temper (Hardness Grade A) is obtained by water quenching from 1450 deg. F.

Hardness, Grade B, is obtained by heating soft material to 1000 deg. F. followed by slow furnace cooling.

Hardness, Grade C, is obtained by heating soft material to 1100 deg. F. followed by slow furnace cooling.

Hardness, Grade D, is obtained by heating cold worked material to 1100 deg. F. followed by slow furnace cooling.

Machining

This new alloy can be machined quite readily and at practical production rates in Hardness, Grades A, B and C. It can also be machined at slow speeds with especially hard tools, e.g. Carboloy, in Hardness Grade D, but this is not recommended and can usually be avoided by machining before final heat treatment.

Like any alloy of properties different from those a machine shop is used to machining, this alloy requires tool angles, speeds and feeds specially chosen to give best results. Sufficient experience has been had in its machining so that procedure can be outlined which will allow the average shop to handle it at outputs, ranging with the type of operation, from half that on machinery steel to nearly the same.

Welding, Soldering, and Grinding

Torch welding is not applicable to K Monel, because of sluggishness due to aluminum oxide. Electric arc welding can be done by using a K Monel welding rod which has been coated with a mixture of:

Cryolite 90%—Wheat flour 10%

This coating can be applied by dipping; 1 per cent of asbestos is added for mechanical binding. The alloy can be brazed with suitable alloys and fluxes.

When grinding it is of the greatest importance to avoid excessive heating, which will change the hardness. It is recommended that grinding be done under water or fluid coolant whenever possible. Because of its greater hardness, K Monel will take a higher polish than Monel metal.

Other Properties

The pickling procedure for Monel metal may also be used on the K alloy.

The demand for castings has not arisen, and there is very little reason to expect much call for them because equal properties can be obtained in other ways more practical to the foundry.

The corrosion resistance of the new alloy is equally as good as Monel metal.

Uses of the New Alloy

The principal uses of K Monel, so far developed in industry, have been where either corrosion or weight saving has been the determining factor. Just as Monel metal is ordinarily chosen because corrosion is to be combatted, so also the choice of K Monel nearly always involves this condition. This combination of considerations has been the determining factor in the use of K Monel for pump rods for use on ships.

Another successful application has been as a thin walled cylinder subjected to high hydraulic pressure in apparatus subjected to mildly corrosive influence but which must function perfectly at any and all times and after long periods of idleness.

The alloy has been used successfully for balls to form check valves where the conditions are corrosive. One particular example is a gas heated water storage tank for domestic use, in which K Monel balls are used as a check valve in connection with thermostatic control. It makes a much better ball than Monel metal, since it is harder, will grind more accurately round and take a higher finish.

K Monel drops and seats have been successfully used in petroleum wells in certain districts, as for example west Texas, where the corrosion conditions are such that iron base alloys do not endure. The corrosive influences combatted here are natural brines containing hydrogen sulphide.

The alloy has been installed as valve trim in valves handling alkaline waters and has given a very excellent performance in this application, superseding harder valve seat materials which were corroded by the water. The water in question was not a contaminated water but was a typical high alkaline city water supply.

It has been used as blades for paper making machinery. It has also been used as blades for flat servers, as illustrated. This application has definite possibilities, the blading offering high corrosion resistance and pleasing color similar to silver.

The material is available as forgings, wire, rods and strip, but not as sheets or tubes.

(Continued from page 100)

of radium used and the distance from the source of radiation.

Where thicknesses of lead for occasional exposure to gamma-rays are given in the Table, they apply to cases where personnel is liable to pass the exposure zone from time to time. When people are doing some other work for any length of time next to the exposure zone, the figures given for continuous exposure should apply. In the original tables the figures are given in metric measures and have been changed by the present writer to suit American usage.

It appears from the Table that very heavy containers are required to transport the radium from place to place. We recommend that this container hang between two long wooden bars which can be carried on each end by one man. In that way a fairly large distance can be kept from the source of radiation, and the lead lining can thus be reduced. The container will slide off readily into a car for further transportation or near the place of its ultimate use.

Table of Lead Protection

Quantity of Radium in gr.	Tolerance distance, Ft. occ.	cont.	Close up	Distance 1 ft.	2 ft.	3 Ft. occ.	cont.	7 ft.	15 Ft. occ.	cont.	30 Ft. occ.	cont.
0.05	3	6	3¾	2 3/16	1	3/16	¾	...	...	...	...	...
0.2	6	10	4½	3⅜	2 3/16	1.0	2.0	3/16	...	...	...	...
0.5	10	20	5 1/16	4.0	3.0	1¾	2¾	¾	...	1/8	...	...
1.0	15	26	5⅝	4¾	3½	2⅜	3⅛	1⅛	...	1/16	...	...
2.0	21	39	6.0	5¼	4.0	3.0	3¾	1¾	3/8	1⅛	...	1/16
5.0	33	61	6⅝	6.0	5.0	3¾	4½	2½	1.0	2.0	1/8	¾
10.0	48	82	7 1/16	6⅝	5½	4⅜	5⅛	3⅛	1½	2½	1/16	1⅜

In the last 10 columns, the figures represent inches.

Letters to the Editor

Another Chuckle

To the Editor: I was interested to read in the February issue of METALS & ALLOYS (1935) your comments on the magic alloy produced by F. H. Maloney & Co., Houston, Texas (page 38).

I wish to report that these people have been completely outclassed by the manufacturers of Atomic Lotan Solder (or their successors) who have produced an alloy which defies one or two of the fundamental laws of science, possessing among other things the property of adjusting its melting point to suit the convenience of the user. Among other things it is stated that "the solder melts and flows at 262 deg. F., and, when it hardens, a temperature of 500 deg. F. is required to remelt it."

In explanation of this remarkable feature, it is stated by the Lotan Division of Robertson-Davis Co., Inc. of Chicago, that "at this temperature (262 deg. F.) the flux contents which completely surround each minute particle of metal, act, setting up a considerable amount of internal heat, and the result of this reaction is fusion of the metal at the above mentioned temperature."

Actually the product is a mixture of 50:50 tin-lead dust and a concentrated aqueous solution of zinc and ammonium chlorides. The solder softens at 358 deg. F. (the melting point of the tin-lead eutectic) and finally liquifies completely at 414 deg. F. independently of the source of the applied heat.

I suggest that all scientists bow their heads in solemn unison and decry the passing of our long established law of the conservation of energy; also let us realize if possible the tremendous inherent exothermic possibilities tied up in a solution of zinc and ammonium chlorides.

CLIFFORD L. BARBER,
Research Chemist
Kester Solder Co.
Chicago

Pickling and Stresses in Steel Castings

To the Editor: The article on "Surface Cracking of Steel Castings During Pickling" by C. W. Briggs and R. A. Gezelius, in your February, 1935 issue, contains data on an interesting subject.

For some time these authors have prosecuted, and progressively reported to the American Foundrymen's Association, researches that throw light on fundamental problems encountered in steel casting manufacture. It is a tribute to the investigators' practical point of view, when doing such work, that they chose specimens for some of their pickling experiments, which, by reason of cast shape, would probably contain stresses of considerable degree, and which, therefore, might have significance in connection with pickling.

A statement from the article cited is here quoted, on which I am prompted to make some comments: "Since embrittlement is found in annealed specimens, it is indicated that even a full anneal does not completely relieve the stress, and in 'commercial' anneals, that are merely a normalizing treatment, there is real danger of cracked castings resulting from pickling." One gathers from the wording and its context that the mention of embrittlement in annealed specimens is meant to include the condition sometimes discovered in commercial products. The general argument in the definite statements and reasonable implications appears to be that full annealing does not completely relieve initial stress; and that normalizing is less effective than is full annealing for the partial relief of initial stress. (Some persons not familiar with metallurgy might incorrectly think the authors believe that embrittlement in specimens that have been full annealed or normalized, *per se,* gives evidence of the presence of some initial stress that has not been relieved.)

It seems to me that deductions might erroneously be made too comprehensively by a few readers, in the absence of any comment on the statement quoted above. The authors have clearly shown, by testing specimens of different cast designs, that the shape of the piece has great influence on the development of stress during solidification and subsequent cooling. It is reasonable to say that (a) many a steel casting may be so well designed from a practical metallurgical standpoint, be so formed in the mold, and be of such chemical composition, that the initial stresses will be so slight as to be inconsequential in service; also that (b) a simple normalizing treatment under suitable conditions of design, chemical composition, and foundry production may so reduce such stresses as need relief that perfect safety will attend the performance of the material.

The satisfactory use of a huge tonnage of steel castings of low carbon content which have had no heat treatment whatsoever indicates that the statement in item (a) is well founded. There is ample substantiation for the premises of item (b) in the enormous tonnage of steel castings for miscellaneous industrial purposes, which have performed perfectly under severe service conditions, after having no heat treatment other than simple normalizing. These comments regarding behavior in service are not made to discount scientific efforts to ascertain the initial or continued presence of stresses produced by shape and/or manufacturing process, but to emphasize the fact that, for practical purposes, it is quite unnecessary either to full anneal or even to normalize certain steel castings to be put into severe service. It all depends greatly on the composition of the steel, the proportions of the piece, and the method of making the mold.

Probably most steel foundrymen will endorse the opinion of the authors that the pickling of steel castings is inadvisable. Perhaps most metallurgists would agree that the harmful effects of pickling are apt to be greater on alloy steel castings having high combinations of physical properties than on carbon steel castings. This seems logical when we remember that surface imperfections generally have more of a bad effect on high-resistant than on low-resistant steel, and that in some cases apparently one effect of pickling is to increase the depth of surface imperfections. Obviously the greater their depth, the more they act as stress-raisers, and the greater becomes the liability of rupture in severe service.

It is very encouraging to see that the investigators at the Naval Research Laboratory, in this pickling investigation and other researches, have shown a practical appreciation of the enormous influence of design on the stress resistance of the steel casting. It is helpful to the steel foundry industry to receive periodically as the results of work done by Briggs and Gezelius, data of fundamental character on which to base sound manufacturing technique.

R. A. BULL

Chicago, February, 1935.

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

Placer Mining in the Western United States. Part II. Hydraulicking, Treatment of Placer Concentrates, and Marketing of Gold. E. D. GARDNER & C. H. JOHNSON. *United States Bureau of Mines, Information Circular* No. 6787, Oct. 1934, 89 pages. Separation of Au and Pt-group metals from hydraulic concentrates, extraction of Au from amalgams, separation of Pt-group metals from Au, and melting Au are discussed. AHE (1)

Milling Activity Largely Confined to Gold-Silver Plants. CHARLES E. LOCKE. *Mining & Metallurgy*, Vol. 16, Jan. 1935, pages 28-30. Milling of Au and Ag ores showed great activity, while milling of base metal ores showed continued depression. Cu production in United States is running at about 15% of capacity. Use of high-speed mills of heater type for crushing native Cu promises success. Gravity stamps continue to diminish in use. New idea in ball milling in treating 2 entirely different ores is used in Colo. mills, and flint pebbles are used instead of steel balls. Explosive shattering of ores offers possibilities. Progress has been made in Dorr equipment. Advances are being made in flotation on non-metallics and near colloidal sizes of sulphides. Au and Ag milling practice is undergoing radical changes. Numerous small Au mills have been erected in Colo. and Cal. Process varies with ore but use of flotation is a noticeable feature. VSP (1)

1a. Crushing, Grinding & Plant Handling

Problem of Reorganizing the Ore Supply of Plants. V. S. ABRAMOV & N. P. SEMENENKO. *Domez*, No. 10, 1934, pages 1-7 (In Russian). In case of ores as different in size and chemical composition as Krivoi Rog iron ores burdening of furnaces is quite difficult, unless the ores are classified and assorted. Present system of sorting is not adequate. A scheme for an efficient classification installation is offered. (1a)

1b. Gravity Concentration

History of Mining in Jicarilla District. M. H. BRIDGES. *Mining Journal*, Arizona, Vol. 18, Jan. 15, 1935, pages 3-4. Most of the gold value of placer material in this district is in fine gold of 160-200 mesh. A survey of the operators of the district is made showing concentration methods in use or proposed. WB (1b)

1c. Flotation

Three-Product Flotation at the Britannia, B. C., Mill. H. A. PEARSE. *Mining & Metallurgy*, Vol. 15, Sept. 1934, pages 379-383. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 554. VSP (1c)

1e. Amalgamation, Cyanidation & Leaching

The Recovery of Gold from the Ore of Ventures Limited, Island Lake Property, Manitoba. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 144-156. Ore samples containing Au 0.46-1.72 oz. and Ag 1.42-4.50 oz./ton, Cu 0.07-0.28, Pb 0.47-3.63, and Zn 1.50-2.95% were cyanided; at —48 mesh there was 5% extraction, at —200 mesh, 78%. Amalgamation recovers 55.45%; cyanidation of tailings 23.9% more. When a flotation concentrate is removed from the plate tailing, given a prolonged cyanidation, and the tailing a short treatment, overall recovery is 94.55%. Removal of coarse Au by traps and blankets and cyanidation of the residue gives over 90% extraction. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

2a. Non-Ferrous

Reduction of Zinc Ores by Natural Gas. H. A. DOERNER. *Progress Reports—Metallurgical Division. 8. Studies in Zinc Metallurgy. United States Bureau of Mines, Report of Investigations* No. 3256, Dec. 1934, pages 3-24.—Chemical reactions, catalytic reaction rates, thermal requirements, apparatus, operating procedure, criteria for control of operations, catalytic poisoning and regeneration, recirculation of gas, condensation of Zn, preparation of raw materials, capacity and the economic possibilities of the reaction $ZnO + CH_4$ are discussed. Retort capacity is about 300 lbs. of Zn/day. Extraction of 95% is feasible. Five cu. ft. of gas produces 1 lb. of metal. The fuel required will be less than that required to heat the present type of commercial furnace. Retort life is about 1 yr.; condensers and refractories should last indefinitely. There is no limit to the life of the catalyst. The Zn produced is nearly as pure as electrolytic. AHE (2a)

Recovery of Zinc from Ferrite Compounds in the Electrolytic Zinc Process. G. L. OLDRIGHT, THOS. B. BRIGHTON & CARL M. DICE. *Progress Reports—Metallurgical Division. 8. Studies in Zinc Metallurgy. United States Bureau of Mines, Report of Investigation* No. 3256, Dec. 1934, pages 25-43. The existence of $ZnO.Fe_2O_3$ as a definite compound was verified. Zn ferrite treated with H_2SO_4 was decomposed at about 600°. Roasting with large amounts of acid made it more difficult to obtain an Fe-free $ZnSO_4$ solution when the calcine was leached subsequently with H_2O. The Fe entered the solution as $Fe_2(SO_4)_3$. Sulfation of Fe and Zn occurred simultaneously. Better results could be obtained by heating the ferrite-H_2SO_4 mixture at a low temperature until complete sulfation occurs, then raising the temperature above the decomposition point of $Fe_2(SO_4)_3$. Sulfation is best carried out in thick beds, decomposition in thin beds. AHE (2a)

No Startling Changes in Lead Metallurgy. CARLE R. HAYWARD. *Mining & Metallurgy*, Vol. 16, Jan. 1935, pages 22-23. Little that is new was produced in Pb smelting and refining industry outside of some makeshifts to make operation at fractional capacity profitable. Parkes process was standardized during period of normal production. At present various short cuts are used in softening, and desilverizing is carried out on irregular schedule. Favorable reports come in concerning the Australian continuous desilverizing practice by means of modified Parkes process. Sintering has received some attention with beneficial effect on blast furnace operation. Au and Ag ores, and Pb bearing material low in S are hard to sinter; this has been successfully solved by using some carbonaceous fuel in making up the charge. United States Bureau of Mines has made a study of sintering and will make a report on it. VSP (2a)

Sulphatizing Roasting of Cupric Oxide. KANJI WANI. *Suiyokwai-Shi*, Vol. 8, June 1934, pages 513-518. In Japanese. CuO was roasted in a stream of SO_2. The influence of SO_2 concentration, temperature, time of heating and the rate of flow of gases upon the yield of soluble $CuSO_4$ was studied. Sulphatizing begins to a small extent at 390°C.; the reaction is important from 500°C. and reaches a maximum rate at 600°C. It is very difficult to convert all CuO to $CuSO_4$ only by passing SO_2, unless the sample is agitated, because of the formation of a coating of basic sulphate on the CuO. HN (2a)

Chemical Reactions in the Copper Smelting Furnace. KANJI WANI. *Suiyokwai-Shi*, Vol. 8, June 1934, pages 477-512. In Japanese. SO_2 was passed over coke, charcoal or sugar charcoal at 690° to 1000° C. Author concludes that the reactions $2SO_2 + 2C \rightleftarrows 2CO_2 + 2S$, $C + CO_2 \rightleftarrows 2CO$, $2SO_2 + 4CO \rightleftarrows 4CO_2 + 2S$ occur. SO_2 is very rapidly reduced for the first 15 minutes; the rate is far greater than that of $CO_2 + C$. Of the C used, the reactivity of coke is the least, and that of charcoal is the greatest. The reduction by coke is considerably diminished below 800° C. Thermal decomposition of pyrite, chalcopyrite and cupriferous-pyrite in N_2 atmosphere was studied. Pyrite shows 3 thermal changes at about 345°, 567°-583° and 650°-775° C. in which the first 2 changes are small in magnitude but the latter is conspicuous. Chalcopyrite has 1 thermal change of small magnitude at about 500°-550° C. and cupriferous pyrite shows 2 changes at about 520° and 720°-755° C. corresponding with those of chalcopyrite and pyrite, respectively. In a neutral atmosphere desulphurization of pyrite amounts to less than 6% at 608°, 42% at 800° and even at 1000° C. 45% of its original S; chalcopyrite loses 5.7% of its original S at 600° and 16% at 1000° C. HN (2a)

2b. Ferrous

Charcoal Blast Furnaces and "Schmer" Furnaces—A Need in Austria (Holzkohlen-Hochöfen und Schmeröfen—eine Forderung in österreich). E. BELANI. *Montanistische Rundschau*, Vol. 27, Jan. 16, 1935, 3 pages. On account of the many advantages which charcoal pig Fe offers in the production of special steels a number of blast furnaces using charcoal have lately been started in Germany. Many blast furnaces of this type formerly were in operation in Austria. The so-called "Schmerofen," a retort-type of furnace in which the tar and other byproducts are recovered, is recommended for the production of the charcoal. This furnace lately has found extended use in Central Europe, Russia, and Japan. BHS (2b)

Utilization of Waste Energy in the Iron Blast Furnace Plant (Die Bewertung von Abfallenergien im Eisenhüttenwerk). ERNST WITTING. *Montanistische Rundschau*, Vol. 27, Jan. 1, 1935, pages 1-3. A discussion of the utilization of furnace gases in the operation of explosion motors and for the production of steam in waste heat boilers, and the advantages of the 2 methods. BHS (2b)

Blast Furnace Operation With Oxygenated Blast. M. A. Shapovalov. *Domez*, No. 10, 1934, pages 7-14 (In Russian). An experimental blast furnace with 12.9 m. useful height, 24.0 m.³ volume and 1.50 m. hearth diameter was used without any hot stoves. About 40% O_2 was added to the cold air. For 23 days the furnace was run on air-dried peat. It ran smoothly producing cast Fe and gas having 2100-2700 calories/m.³ With forced operation the charge remained in the furnace but 5 hours, and in the reduction zone only 2 hours, the rest of the furnace being used for peat carbonization. On melting ferromanganese with coke and oxygenated blast, metal with 82% Mn and 0.13-0.48% Si was produced, but the slags carried 30-37% MnO (though the ratio $CaO:SiO_2 = 1.06$-1.75 was maintained) because of the cold core in the hearth due to the lack of pressure. For 1 month the furnace was run to make 11-14% Si Fe with increased content of C, Cr and Ni. Considerable trouble was experienced on account of the abundant formation of amorphous C by decomposition of the gas very rich in CO in the upper layers. Wide fluctuations in the analysis of both slags and Fe were observed. The desired Si content was not obtained. A maximum of 10.96% was reached once, but on the average casts ran little above 5% Si. No relation between Si content in the Fe and $(SiO_2 + Al_2O_3)$: CaO ratio could be observed. S could not be controlled in the Fe. Top gases contained 6.6-19.4% CO_2, 30.8-52.8% CO, 3.7-15.1% H_2, 0.3-0.8% CH_4. Reduction of FeO by CO takes place in a blast furnace within a comparatively narrow temperature range of 500-900°C. The region of this temperature interval in the shaft of the furnace might decrease with the decreasing volume of the gases caused by use of O_2. The upper parts of the shaft would not be used in this case for reduction reactions. In the 13 m. blast furnace the top temperature was only 250°C. suggesting that in larger furnaces it would be much lower. Thermal capacity of the top gases varied between 1600 and 1800 calories depending on O_2 supply. With increasing O_2 content the combustion zone decreased inversely proportionally to it. Decreasing volume of hearth gases destroys the equilibrium which is observed under normal operating conditions. (2b)

Operation of a Minette Blast Furnace With and Without Scrap (Betriebsergebnisse eines Minette—Hochofens ohne und mit Schrottzusatz). M. Steffes. *Stahl und Eisen*, Vol. 55, Jan. 3, 1935, pages 17-20. Numerous tests indicated that at a blast temperature of 800°C. the consumption of coke per ton of 1 pig Fe from scrap was about 286 kg. Blast furnace gas and air volume decreased sharply with increasing scrap. The composition of the blast furnace gas and its calorific value changed but little, although its temperature rose slightly. SE (2b)

Volatilization of Silicon and Silica by Sulphur and Its Practical Application (Über die Verflüchtigung von Silizium und Kieselsäure durch Schwefel und ihre Bedeutung für die Praxis). Paul Dolch. *Montanistische Rundschau*, Vol. 27, Jan. 1, 1935, pages 3-4. A historic review of the studies on the formation of volatile Si sulphide in Fe smelting, a reaction first suggested by Ledebur in 1878. These studies explain the fact that in electric smelting of pig Fe, with 2 a comparatively high content of S in the charge, a pig Fe with less than 0.01% S may be obtained, even without any CaO in the charge. A high furnace temperature promotes the removal of S. BHS (2b)

Blast Furnace Fuels: Their Regional Influences. Ralph H. Sweetser. *Iron Age*, Vol. 134, Nov. 29, 1934, pages 20-28, 74. An analysis of part played in geography of the steel industry by blast furnace fuels. Reviews the records of the building of all blast furnaces in the Colonies and in the states of the Union to study the influences that brought about the location of blast furnaces at the places they were built and what caused their disappearance or their continuance 3 in that region. The 4 distinct blast furnace fuel eras are as follows: Charcoal period 1645 to 1855; Anthracite period 1855 to 1875; Beehive coke period 1875 to 1919; and By-product coke period 1919 to date. Discusses each era. Includes tables showing the number of blast furnaces on active list at end of each year, 1645 to 1933 and number of blast furnaces built in U. S. from about 1840 to 1934. VSP (2b)

3. MELTING, REFINING AND CASTING

Surface and Venting Properties of Molding Sands. J. Verö. *M. Kir. Joszef Nador Müszaki es Gazdasagtudomanyi Edgyetem Banya-, Koho- es Erdömernöki Kar, Sopron (Royal Hungarian Palatin-Joseph University of Technical and Economical Sciences, Faculty of Mining, Metallurgy and Forestry of Sopron)*, Vol. 6, Dec. 1934, pages 99-119. In English. Tests were made with the apparatus of Steinitzer to investigate the influence of grain size upon the venting property of molding sands; only quartz sand free of clay and dust was used. A linear relationship exists between the factors expressing the venting property, namely the time occupied by the passage of a gas, and the difference of pressure which is effected by the passage of the gas. Another linear relation exists between the square root of the resistance and the reciprocal dimensions of the grains but only for grains of equal size and sands free of mixtures; the latter have always greater resistance than pure quartz sand. The surface factor, i.e., the whole surface of grains contained in a unit of volume or weight, is of determining influence. Ha (3)

Die-Cast Wheel Hubs and Caps. E. Stevan. *Mechanical World & Engineering Record*, Vol. 97, Jan. 4, 1935, pages 5-6. Example showing, that by substituting die castings for parts which previously have been made from pressings or sand castings, considerable economies can be effected. Description of dies and production procedure. Kz (3)

Controlling Dry Sand Strength. H. W. Dietert & F. Valtier. *Foundry*, Vol. 62, Dec. 1934, pages 24-25, 56. Methods in use for controlling dry sand strength are: Mixing; the additions of water, pitch, cereal binders, bentonite, plastic clays and molding sands of high dry sand strength. Duration of mixing has its effect on both green and dry properties of molding materials. Green strength and mold hardness of sand show the same trend, having maximum value at 9 min. of mixing. Green and dry permeability shows an increase up to 12 min. of mixing. Low moisture content results in a low dry sand strength while a high moisture will result in a higher dry sand strength. Dry sand strength may be increased by addition of pitch. It also acts as a facing material. Binders made from corn and wheat are used in sand mixes for baked cores and dried molds. Bentonite increases both green and dry sand strength. Bonding clay made of pulverized plastic fine clays is a practical bonding material. It retains dry sand strength at high temperatures. Surface appearance of casting is improved if formed in dry sand. VSP (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Melting and Casting of Special Brass Alloys. Leo S. Ivanoff. *Metal Industry*, London, Vol. 45, July 6, 1934, pages 7-10. The author endeavors to point out the characteristic properties of the special brasses and the factors contributing to the successful melting and casting of these brasses. He believes that when these special brasses are properly handled that the percentage of "misruns" should not be greater than with the ordinary 60:40 brass. The "Zn equivalents" of a number of elements are given and the advantages of using these elements are discussed. The necessity of remelting, especially if "hardeners" are used to introduce these elements into the melt, is emphasized. The correct method of producing "hardeners" is discussed and a recommended method given in detail. The time for the addition of secondary metal and the permissible amount to be used are indicated. Another factor given consideration is the addition of some Zn to compensate for that lost due to volatilization. This is not recommended. The author suggests melting under a borax slag that is thickened with sand but not removed before pouring. Special care in the preparation of the sand mold and bottom pouring if possible are deemed essential. HBG (3a)

Fluxes and Slags in Brass Foundry Melting Practice. T. Tyrie. *Metal Industry*, London, Vol. 44, May 4, 1934, pages 461-464; May 11, 1934, pages 487-490; May 25, 1934, pages 540-541. A paper read before the Scottish Section of the Institute of Metals. Until recently it was believed better results were obtained in melting non-ferrous metals if additions were minimized. Recently the subject has been given serious study on a logical basis and chemical 5 mixtures evolved which are beneficial. Results obtained justify the inclusion of the subject as of major importance. The subject is restricted to the use of deoxidizers, slags, etc., in the melting of metals to produce castings and is discussed under (1) commonly occuring impurities; (2) removal of these impurities by the use of fluxes and slags; and (3) the presentation of data obtained on metal so treated. Under (1) are included all substances which may be regarded as having a detrimental influence on a particular alloy. The influence of the presence of a number of these substances on Cu, bronzes, gun-metal, Ni, and Al alloys and of gases are specifically discussed. The author believes that the rate 6 of absorption of O and certain other gases is governed by the Zn content of brasses. Under (2) rapid melting in a slightly oxidizing atmosphere is recommended. Author recognizes that many fluxes are deoxidizers but makes an arbitrary distinction between fluxes and deoxidizers for the discussion. Both are defined, as is an ideal deoxidant. Deoxidizers are suggested for a number of different classes of metals. The advantages and disadvantages of P, Mn, Si and Al are indicated. A method for the addition of deoxidizers is given. The functions of fluxes and slags are (a) to act as solvents for metallic oxides, (b) means of removing inclusions, (c) coverings to prevent oxidation and gas absorption and (d) as degasifiers. A low viscosity is essential to be effective. Comments are given on 7 a number of fluxes now being used. The refinement of Al by gaseous compounds is discussed. A table is given of the physical tests of a number of alloys made wholly from scrap. The author believes that faulty melting practice can not be wholly corrected either by the use of deoxidizers or fluxes but that it is possible, when efficient melting can not be obtained under existing conditions without radical alterations, to produce higher grade metal by the judicious use of both deoxidizers and fluxes. HBG (3a)

Production and Casting of Magnesium Alloys (Herstellung und Giessen von Magnesiumlegierungen). E. T. Richards. *Die Metallbörse*, Vol. 24, June 16, 1934, pages 761-762; June 23, 1934, pages 794-795; June 30, 1934, pages 826-827. Data are given showing the beneficial effect of 6-8% Al on the physical properties of Mg. The difficulties in casting Mg alloys are due to its affinity for 8 O and N, its explosion-like reaction with moisture and chemical reaction with SiO_2. Only cast Fe and steel crucibles provided with closely fitting covers should be used. Most suitable mixture for covering the melt is 65-70% $MgCl_2$, 23-25% KCl, 4-5% NaF, 3-4% CaF_2. Unfortunately the best fluxes for Mg alloys are patented. Gas or oil fired furnaces are most widely used. Traces of chloride bath layers are liable to be retained by the casting resulting in lower corrosion resistance. Mg melts are purified with S. Two different methods for use of Mg 9 scrap in foundry work are considered. According to the author's practice, the flux mixture (30-50 wt.% of alloy to be melted) is heated to 750°-800°C. Then the scrap is gradually added beginning with the heavier parts. This method does not require careful removal of foundry sand from the scrap. The flux mixture can be used for 3-5 melts. Casting temperature: 675°-725°C. Fe and steel molds can be used. Even cast Fe molds suffice. Former failures due to porosity of chill castings are ascribed to insufficient preheating of the molds. Smoother casting surfaces are obtained by sprinkling a coating of water glass into the Fe molds before heating the latter to 300°-400°C. Sand casting is feasible. To insure absence of traces of moisture, the green sand molds should be "hand-warm." 0 Glycerine, ethylene-glycol, ceresin, naphthalene, sulphur, boric acid are added to the sand. S vapor prevents direct contact between the sand particles and the liquid Mg alloy. The S loss is relatively small since S condenses in the colder parts of the mold. Chilled surfaces should be treated with a suspension of pure graphite in alcohol. Excessive ramming of the sand molds should be avoided. EF (3a)

Studies in Cast Bronzes. FRANCIS W. ROWE. *Foundry Trade Journal*, London, Vol. 50, June 7, 1934, pages 363-366. Paper read before the Annual conference of the Institute of British Foundrymen 1934. Practically all the cast bronzes made under normal conditions containing about 5.5% Sn show the presence of the $\alpha - \delta$ eutectoid which increases as the quantity of Sn rises until at about 28% Sn the alloy consists entirely of this hard and brittle constituent. Varying quantities of this compound materially affect the physical properties of the bronzes. Apart from the differences due entirely to composition, there come the large differences which may result due to casting conditions and mass of the casting. A number of density-casting temperature curves of different alloys cast in dry sand molds are presented by the author. The results of physical tests are also given. AIK (3a)

Molding and Casting of Locomotive Castings for the German Railway (Formen und Giessen von Lokomotivguss für die Deutsche Reichsbahn). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Nov. 25, 1934, pages 493-495. Molding and casting of (1) guide for spring support and (2) valve cock of locomotive whistle are considered. Gating and core making are discussed at length. The castings were made of Rg 5, a standardized German red brass containing 85% Cu, 5% Sn, 7% Zn, 3% Pb. High pouring temperature is recommended. GN (3a)

Electrolytic Refining of Tin (Die elektrolytische Raffination von Zinn). WERNER FRÖHLICH. *Die Metallbörse*, Vol. 24, June 30, 1934, pages 825-826; July 7, 1934, pages 859-860. Tin with 15-20% impurities (Pb, Sb, Cu, As, Bi, Zn) can be electrolytically refined. The Betts process failed with Sn because of the different behavior of gelatine in fluosilicic acid electrolytes. An electrolyte comprising 20% H_2SiF_6, 0.1% H_2SO_4, 6% stannous-Sn and small additions of glue and cresylic acid has been replaced by 8% H_2SO_4, 5% H_2SiF_6, 3% stannous Sn and the same colloidal additions. H_2SiF_6 has also been replaced by benzene, phenol, cresol, etc., 0.25-0.3% HCl is sometimes added. The acid electrolysis operates at 35°C. and about 1.1 amps./dm.^{2} current density. The Sn electrolysis in HCl is discussed critically. Contrary to American practice, alkaline electrolytes are prevalent in continental plants which generally use a 10% Na sulphide solution containing S or NaOH additions. Na sulphide is regenerated automatically and calls for replenishment only every 3-4 weeks. Anodes of 90% purity are widely employed although tests with 75% Sn anodes were successful. However the anode slime contains 10% Sn if anodes with 20% impurities are electrolytically refined. Sb contents of over 5% render the whole electrolysis uneconomical. Bath temperature=90°C. Tanks are Fe. No stirring. Anodes : 10-15 mm. thick. Cathodes : tin coated Fe sheets of 3 mm. thickness. Current density=0.5 amps./dm.^{2} Tin content in electrolyte=8-11 g./liter. Anodes and cathodes must always exhibit a bright metallic luster. EF (3a)

Action of Products of Combustion (Gas furnace atmosphere) on Slagging in the Brass Industry (Die Wirkung der Verbrennungsprodukte (Ofen-Gasatmosphäre) auf den Metall-Abbrand in der Messing-Industrie). R. KÜHNEL & A. PUSCH. *Zeitschrift für Metallkunde*, Vol. 26, Aug. 1934, page 189. Following the experimental procedure of C. Upthegrove and A. J. Herzig (University of Michigan Engineering Research Bulletin, No. 22, Dec. 1931) the rate of metal loss on exposing molten brass to gas atmospheres, consisting of mixtures of CO_2, CO, O_2, N_2, H_2 and CH_4 has been investigated. It is demonstrated that the metal loss increases with increasing temperature, rate of gas flow, and duration of the test. Two distinct mechanisms are found to be operative in bringing about metal loss (1) vaporization and (2) oxidation. Vaporization is hampered by the presence of an oxide layer on the surface of the metal. Hence, to insure a minimum metal loss, high zinc brasses should be melted in an oxidizing atmosphere while low zinc brasses should be melted in a neutral atmosphere. FNR (3a)

Melts Bronze in a Small Cupola. JOHN DUFFY. *Foundry*, Vol. 62, Sept. 1934, pages 20-22, 64. Contrary to general belief, the cupola is well adapted to melting bronze or red brass. The past few years a special coke having an analysis of 98.5% fixed C, 0.4% S and 0.5% ash, and a modified type of cupola have been developed for melting bronze and brass. Gives an example of the methods, materials and equipment used in a typical installation of 2 cupolas. One cupola melts an alloy of 80% Cu, 10% Sn and 10% Pb. The other cupola melts a modified form of ordinary red brass of 85% Cu, 5% Sn, 5% Pb and 5% Zn. Includes approximate cost per ton of metal. VSP (3a)

Mixtures for Small Propellers. JOHN DUFFY. *Foundry*, Vol. 63, Feb. 1935, pages 29, 61. Concerned with proper method of casting propellers. Metal usually used is Al-bronze of 87% Cu, 9% Al, 3% Fe and sometimes 1% Zn. When many duplicate castings are ordered it is advisable to mount pattern on follow board instead of match plate. Melting the metal offers certain difficulties but if proper procedure is adopted results will be satisfactory. Gives proper methods of mixing metal. VSP (3a)

Casts Bronze Chains in Core Molds. *Foundry*, Vol. 62, Aug. 1934, pages 24-25, 59. Describes method of procedure used by Alliance Brass & Bronze Co. Process consists of casting a number of single links in usual manner. That is the required number of link patterns to fill a flask are mounted either as whole links on flow board, or as split patterns on a flat board. Resulting castings are cleaned and placed in suitable depressions in chain cores. These cores are placed end to end for any given distance with links lying horizontal and cavities for connecting links in vertical position. A runner in cope section of core conducts metal to two of these links and result is a unit of 5 links. Process is repeated until sufficient number of links have been joined to form required length. VSP (3a)

American Copper Metallurgists Learn to Handle Scrap. C. W. EICHRODT. *Mining & Metallurgy*, Vol. 16, Jan. 1935, pages 26-27. Due to existing feeling that intense competition will return, careful investigations are being made in improving industrial position and production methods. In many localities remodeling of plants has been made. Low rate of production of primary Cu has increased importance of secondary metal. Serious consideration is given to treatment of "white matte," or Cu-Sn alloy, a refinery by-product. Improvements have been made in sweating solder-bearing scrap Cu and in purification of resulting solder. Increased interest is given the refining of scrap Cu. Many advocate producing products that will dissipate Cu beyond recovery. A paint has been developed containing 5 lb. per gal. of Cu powder which may find application in marine service. Foreign Cu industry has increased. VSP (3a)

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Bronze and Brass for the Metal Foundry (Brons en messing voor de metaalgieterij). IR VAN DER VELDEN. *De Gieterij*, Vol. 8, Mar. 1934, pages 30-33. The author claims that of the numerous bronzes and brasses only a few are interesting to the foundry. Besides the influence of the normal constituents, Sn, Pb and Zn, that of other additions like P, Mn and Al are examined. Among the brasses standard brass and Muntzmetal are considered with the effect on them of additions of Sn, Pb, Al and Fe. The whole is then summarized as to the effect on grain size, resistance to sea water, fusibility, etc. In the case of Ni additions the author claims little is as yet known to be of interest to the foundry operator. The influence of re-melting is discussed. MPW (3a)

Practice of Melting in the Foundry (Het practisch smelten in de metaalgieterij). A. SCHNEIDER. *De Gieterij*, Vol. 8, Apr. 1934, pages 51-52. This article, which concludes an article in September, 1933, on the melting of red Cu deals with the melting of bronzes and brasses. In considering the different qualities of Sn used at present the author refers to Banka tin as the best on the market. The Sn pest or gray Sn is explained and the means of avoiding its occurrence. Author also explains in detail the methods of melting, de-oxidation in or outside of the crucible, the danger of even slight traces of Al, the advantages of CuP for deoxidation or for the addition of extra P for the production of the phosphor bronzes as well as the great care with which the remelting should be done. MPW (3a)

Progress of the Die Casting Industry. L. M. WAITE. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 119-120, 123-126, 246. Discusses the die casting industry which began as a competitor of metal working field and has made itself an integral part of the industry. The past year was one of marked cooperative endeavors to broaden fields of applications. In this all elements of the industry cooperated and results were notable. Eager competitive endeavor resulted in much experimental work. VSP (3a)

Removes Dust at the Shakeout. W. G. GUDE. *Foundry*, Vol. 62, Aug. 1934, pages 21, 59. Describes a system for eliminating dust installed in brass foundry of Sloan Valve Co., Chicago. The unit consists of a high-speed fan, 2 wind boxes, located at opposite side of shakeout, a preliminary and secondary dust collecting hopper and a blow pipe. Blast box is located along full length of shakeout and is 2 ft. high and 10 in. wide. Welded seams make it air tight. Face built about 1 in. from edge facing shakeout has ½ in. slot on top and 2 sides. Blast of air from slot prevents dust from rising, blowing it to other side of shakeout, where it is drawn into suction box. VSP (3a)

Allowing for Camber on Long Single Casting. J. H. EASTHAM. *Iron Age*, Vol. 134, Aug. 30, 1934, pages 22-23, 66. Gives an illustration of a large job done in a small foundry. Describes casting of a light oblong machine frame of channel design, 16 ft. long, 4 ft. wide, 8 in. deep, and weighing 1600 lb. Delivery to be made within 4 days. No flask was available and cores were used as cover instead of a cope. Feature was the use of coreprints requiring no chaplets. The casting was 0.80% Mn. VSP (3a)

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3b. Ferrous

C. H. HERTY, SECTION EDITOR

Centrifugally Cast Electric Cast Iron Pump Piston Cores. A. E. Falk. *Metals & Alloys,* Vol. 6, Jan. 1935, pages 7-10. Describes foundry layout as to furnace, mold conveyor and stripping bench for the production of cast iron piston cores for slush pumps used in oil well drilling. Electric furnace iron, C 3.10%, Si 2.30%, Mn 0.70%, P 0.242%, S 0.066% is poured into spinning molds. Molds are first cast and machined for small sizes of castings and as heat checking occurs they are remachined for larger castings. Two types of iron are used for molds, (1) C 3.50%, Si 3.90%, Mn 0.80% and (2) C 3.20%, Si 2.50%, Ni 4.00%, Mo 0.50%. Since metal falls directly on the core in pouring, sand cores cut and washed badly and metal cores were resorted to. After some experiments the following was found most satisfactory: C 3.20%, Si 1.50%, Ni 34.00%, Cr 2.50%, Mn 0.80%. Heat treatment and machining practice are briefly discussed. Micrographs show no graphite flakes in centrifugally cast iron. WLC (3b)

Iron Superheated in Open Hearth. Frederick Brocke. *Foundry,* Vol 63, Feb. 1935, pages 32, 64. Melting large % of steel scrap or low C pig Fe in cupola for production of high test Fe, and subsequent molding to obtain desired results, has been the problem for sometime. Use of alloys in charge serves useful purpose and increased cost is justified by resultant economies. The most recent development is the Schury furnace used in production of high grade gray Fe, malleable Fe and steel castings. Furnace shell is either circular or rectangular, is built of steel plate and lined with refractories that will withstand variations in temperatures from irregular working. It may be stationary or tilting type and is mounted above 2 air superheaters. Superheaters provide hot secondary air for perfect combustion. Hot secondary air is mixed with fuel, and temperature of about 3600° F. is produced. High temperature coupled with neutral atmosphere produces Fe of high quality and with little oxidation loss. Charge of normal composition is refined in 1 hr. Furnace is very flexible lending itself to either continuous or intermittent operation. VSP (3b)

Makes Large Generator Casting. *Foundry,* Vol. 62, Sept. 1934, pages 29, 44. Describes casting of a cylinder base for a turbine generator set rated at 183,333 Kv.-amp. by the Westinghouse Elec. & Mfg. Co. Weight of cleaned casting is 175,000 lbs. Additional weight of gates, risers and melting loss needed 210,000 lbs. of Fe melted in 2 air furnaces and 2 cupolas. Casting did not vary at any place more than ¼" from anticipated dimensions. 1/10" contraction was allowed instead of usual ⅛". VSP (3b)

Producing Malleable Castings. *Foundry,* Vol. 63, Jan. 1935, pages 16-18, 46, 48. Describes the Jefferson division plant of the Lockport Fittings Co., Inc., producing malleable castings. VSP (3b)

Prevents Losses with Proper Gates and Risers. Pat Dwyer. *Foundry,* Vol. 62, Aug. 1934, pages 34, 36, 39; Sept. 1934, pages 38, 40, 43; Oct. 1934, pages 61, 64, 67; Dec. 1934, pages 47, 49-50; Vol. 63, Feb. 1935, pages 42, 45, 48. *55th instalment.* Recommends the use of skimmer gates in steel casting where the metal is poured directly over the lip due to hazard of some of the slag flowing into the runner with the metal. Where the metal is poured from a bottom pour-ladle or teapot top ladle no skimmer is necessary. *56th instalment.* Discusses the proper use of gates and risers in green sand molds when casting steel. *57th instalment.* Discusses the casting of steel chains with special reference to gates and risers and with additional data on some of the related features. Method involves the stacking of the molds, containing 8 links, 5-high to produce 40 separate links at one pouring. Secondly these precast links are placed in a second series of molds where connecting links to the number of 36 are poured around them. Gates are arranged to discharge into feeding heads and thence into mold cavities. *58th instalment.* Gives examples of the manner in which gates and risers are applied to steel castings ranging in weight from 5 to about 300 tons. On these castings the problem of gating is simplified through nozzle limitation on the ladle. Metal should be poured into top of mold to provide hot metal in area where needed to compensate for shrinkage. It is advisable in majority of cases to provide one or more additional gates particularly on molds where metal has to climb to a considerable height. Speed of metal entering through bottom gate is retarded by back pressure of metal already in the mold. This pressure increases as height of metal in mold approaches the height of metal in sprue. *60th instalment.* In design of gates for malleable castings the rapid loss of temperature and fluidity is of great importance. Metal must be poured rapidly and therefore large sprues, runners and gates must be used. Large gates and supplementary risers have another function in supplying metal to compensate for shrinkage, which otherwise will cause cavities, porous areas and also cracks in castings. Proper thickness of sand between patterns depends on size and particularly on depth of castings. VSP (3b)

Bessemer and Open-Hearth Steel Wire. F. H. Nullmeyer. *Wire & Wire Products,* Vol. 9, Dec. 1934, page 439-444. The manufacture of basic and open-hearth steel wire in all its stages from ingot to finished product is described. Ha (3b)

The System Iron-Iron Oxide-Calciumorthoferrite (Das System Eisen-Eisenoxyd-Kalziumorthoferrit). E. Martin & R. Vogel. *Archiv für das Eisenhüttenwesen,* Vol. 8, Dec. 1934, pages 249-254. Samples composed of Fe, Fe_2O_3, and CaO were melted in platinum crucibles and the cooling curves and structures studied. In the region $(CaO)_2 . Fe_2O_3$ — CaO . $(FeO)_9$ — Wüstite — CaO . Fe_2O_3 two new crystal forms were found approximating the formulae CaO . $(FeO)_9$ and $(CaO)_4(Fe_3O_4)_3$. Through these 2 compounds the region studied was divided into 5 ternary and 1 binary phase fields. Free Fe appears on passing beyond the sections $(CaO)_2 . Fe_2O_3$ — CaO . $(FeO)_9$ and CaO . $(FeO)_9$ — Wüstite toward higher Fe contents. Free CaO together with free Fe were found in samples which contained more CaO than indicated in the section Fe — $(CaO)_2 . Fe_2O_3$. SE (3b)

Influence of Manganese on the Constant K"Si in Acid Martin Steel (Influence du Manganese sur la Constante K"Si dans l'Acier Martin Acide). P. Herasymenko & F. Poboril. *Chimie et Industrie,* Vol. 32, Sept. 1934, pages 528-529. In the establishment of the equilibria of deoxidation in which FeO is precipitated by the action of Fe and Mn silicates the authors show that the action occurs only where the Mn content is high and that it rarely occurs in practice or in the ordinary manufacture of steel. MAB (3b)

Relations between the Time of Blow in the Basic-Bessemer-Converter and the Yield (Beziehungen Zwischen der Blasezeit im Thomas-Konverter und dem Ausbringen in der Zurichtung). R. Frerich & T. Lütgen. *Stahl und Eisen,* Vol. 54, Dec. 27, 1934, pages 1329-1333. Studies over several campaigns indicated that there is a relation between the time of blow in the basic-bessemer process and the yield, the latter being appreciably greater the shorter the blow. Ascertaining the most favorable time of blow should enable improving the quality of the steel. SE (3b)

Sweep Split Molds Off Two Centers. J. H. Eastham & J. McVey. *Foundry,* Vol. 62, Aug. 1934, pages 22-23, 56, 59. Foundries specializing in mill and mining repairs, and general engineering work may be called upon for flywheels, pulleys, rings, winding drums, etc., on short notice, without proper equipment. In such cases the principle of sweeping up on oval mold is resorted to with extreme accuracy. Gives an example of a typical pair of half castings machined to 8 ft. outside diameter, 12 in. thick and 12 in. deep. Roughly the casting weighed 10,000 lbs. VSP (3b)

Foundry Melts 2000 Tons a Day. Pat Dwyer. *Foundry,* Vol. 62, Oct. 1934, pages 42-44, 96; **Cupolas Supply Molten Iron Continuously,** Nov. 1934, pages 28-30, 80; **Foundry Doubles Plant Capacity,** Dec. 1934, pages 20-22, 55; **Hold Cores To Close Tolerances,** Vol. 63, Jan. 1935, pages 28-30, 60, 62. Describes the foundry of the General Motors Corporation at Saginaw, Mich., with a daily capacity of 200 tons and employing 900 men. This foundry produces parts for Chevrolet automobiles. Gives details of plant layout, equipment used and methods of procedure. VSP (3b)

Large Brass or Bronze Products Cast Centrifugally. Edwin F. Cone. *Iron Age,* Vol. 134, Dec. 13, 1934, pages 24-26; *Foundry,* Vol. 62, Dec. 1934, pages 18-19, 58. Describes centrifugal casting of large cylinders and similar shapes on a commercial basis by the Bethlehem Steel Co. Includes brief historical review of centrifugal casting of metals and its advantage. VSP (3b)

Specializes in Jobbing Castings. Edwin Bremer. *Foundry,* Vol. 63, Feb. 1935, pages 26-28, 58. Deals with the development of a gray Fe Meehanite and describes the production of jobbing castings by the Hamilton Foundry Co. The process of obtaining Meehanite consists essentially of steel scrap additions to cupola charge, and adding Ca silicide to ladle. It is claimed that in production of special Fe, its Si content need not be held within strict limitations that are necessary with usual steel scrap mixtures, but within certain limits, steel content must be increased with Si content. Describes some of the applications of Meehanite metal. VSP (3b)

Making the Mold of a Slide Valve Casing with Round Hood Flange by Means of Frame and Sweep (Herstellung der Form für ein Absperrschiebergehäuse mit rundem Haubenflansch mittels Rahmen und Schablone). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Dec. 9, 1934, pages 505-507. The slide valve casing, the molding which by means of molding frame and sweep is described in detail, possessed an inner diameter of 1000 mm. The lower part was molded in the foundry floor the upper in a flask. The core for the interior of the casing was made of the mold. GN (3b)

1

Processing of a Slide Cylinder Cover with Sweep (Herstellung eines Schieberzylinderdeckels mit Schablone). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 25, 1934, pages 498-501. Paper considers mold arrangement including sweeps and auxiliary patterns required in making mold. GN (3b)

Making the Mold of the Hood of a Slide Valve Casing with Round Flange (Herstellung der Form für eine Absperrschiebergehäusehaube mit rundem Flansch). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, pages 479-481. Detailed discussion of molding procedure applied. The hoods were molded in flask in vertical position, hood flange upside, by means of spindle and sweep. GN (3b)

2

Open-Hearth Technicians Argue Production Problems. *Iron Age,* Vol. 134, July 5, 1934, pages 36-40. From June meeting of the open-hearth division of the American Institute of Mining & Metallurgical Engineers held at Pittsburgh. The greatest benefit derived from the conferences is the abolition of a large amount of duplicate basic experimentation on steel development and plant rehabilitation. Moll type checker wis given considerable attention. Recent experiments of Cu molds and stools should result in decided improvements in pouring action and condition of the steel. Other topics considered were the use of low amount of residual Cu in steel, use of "cheapeners" in blast furnaces and the close control of the quality of rimming steel by making oxide analyses late in the heat although early estimate can be judged from fluidity of slag during melting. VSP (3b)

3

Accurate Control and Inspection for Quality Steel Production. *Iron Age,* Vol. 134, Sept. 6, 1934, pages 24-27. Outlines method used at the plant of Timken Steel and Tube Co. in production of steel of uniform high quality by accurate control and inspection of its production. VSP (3b)

4

Electric Furnace Cast Iron Practice. H. H. WALTHER. *Transactions American Foundrymen's Association,* Vol. 5, Aug. 1934, pages 32-48. Presented as A.F.A. exchange paper before the 1934 meeting of the Association Technique de Fonderie. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 4. CEJ (3b)

Malleable Iron and the Maurer Diagram (La Fonte malléable et le Diagramme de Maurer). TRY-CHALONS. *Revue de Fonderie Moderne,* Vol. 28, Nov. 25, 1934, pages 328-329. The application of the Maurer diagram for determining the relation of Si to C in the case of malleable Fe is briefly demonstrated and recommended for practical use in foundries. Ha (3b)

5

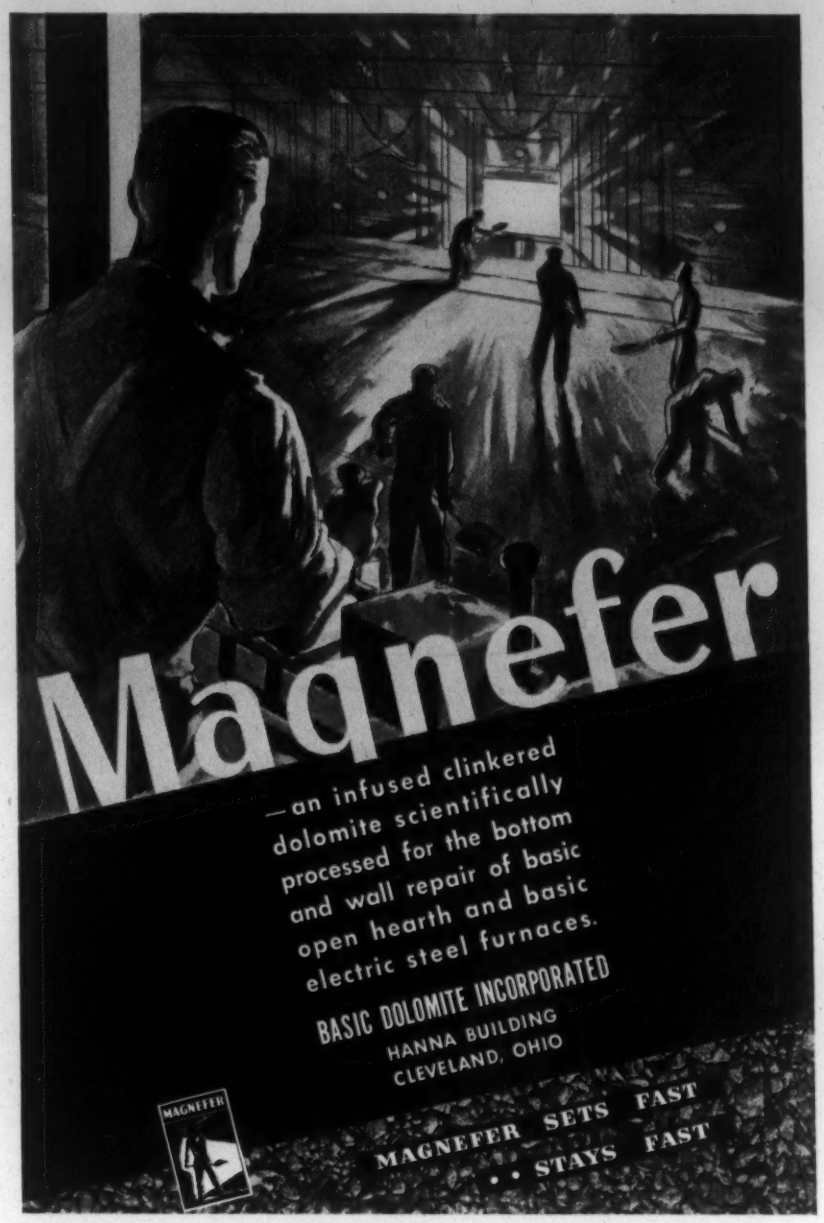
Methods for Determining Oxygen in Steel—A Progress Report. J. G. THOMPSON. *Mining & Metallurgy,* Vol. 15, May 1934, pages 215-216. From a report on project 8411 of U. S. Bureau of Standards, sponsored by the Iron and Steel division of the American Institute of Mining Engineers. An attempt is made to define more concisely the accuracy and limits of usefulness of various methods in use for the determination of O as it exists in ferrous materials. For the present it was decided to limit consideration to C steel and to limit the number of steels to six. The cooperation of a number of concerns in this and various foreign countries has been obtained. VSP (3b)

Temperature of Molten Steel. *Engineer,* Vol. 158, Oct. 5, 1934, page 346. From paper by R. S. Whipple read before a joint meeting of Section A (Mathematics and Physical Sciences) and Section G (Engineering) of the British Association for the Advancement of Science, Sept. 6, 1934. LFM (3b)

Recent Developments in British Synthetic Molding Sand Practice. JOHN J. SHEEHAN. *Foundry Trade Journal,* Vol. 50, June 21, 1934, pages 391-394; June 28, 1934, pages 410-413, 415. Paper read before the annual Conference of the Institute of British Foundrymen held at Manchester, June 5-8. Problem was to develop a molding sand that would operate successfully as a gray iron, a steel, and a jobbing floor sand. Difficulties encountered due to low permeability and high strength, and inability of mixers to function rapidly, were overcome by a simple adjustment of the sand mixture. Surface of irregular sand grains covered with ferruginous bond (burnt on ferric hydroxide) assists in the increase of the sand strength. Synthetic sands made up using rounded, smooth-grained sands sometimes lead to difficulty. Strength of mixture obviously a function of the surface tensions between the water-carrying clay bond and the quartz surface conditions. Absence of soluble and easily fusible alkalies is indication of high refractoriness. When percentage of combined water is not driven off at 110°C. "good life" may be expected. The blending of synthetic sands to obtain suitable properties for this particular use is described. Suggests burning on of aluminum oxide to sand grain to increase refractory and life properties. Further work in progress. CEJ (3b)

Modern Foundry Production Methods. J. J. SHEEHAN. *Journal Institution of Production Engineers,* Vol. 13, Oct. 1934, pages 527-549. Includes discussion. Reviews the layout, equipment, and control of a cast iron foundry. Attention is directed to the possibilities of using a cupola and high-frequency furnace combination, and of developing a continuous sand mixer and reconditioner. Examples are given of modifications to the design of automobile castings to facilitate production. Specification control of raw materials, process control, and investigation of defects are discussed. JCC (3b)

Foundry Facings. H. N. BASSETT. *Foundry Trade Journal,* Vol. 51, Aug. 30, 1934, page 134. Sources and composition of graphite, assessing values of graphite facings and other facing materials are discussed. The criterion is the extent to which the facing material partakes of a flaky character, for no matter how finely ground the facing may be, the molten iron finds its way between the grains, whereas it is stopped by the flakes. A blacking with a high carbon content but no flakiness would be likely to be less satisfactory than a graphite containing a fairly high proportion of ash, but nevertheless with the flakiness characteristic of the material. AIK (3b)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Processing of Pattern Plates for Molding the Rake Faces of Grass Mowers (Herstellung von Modellplatten zum Formen der Rechenbahn für Grasmäher). W. SCHNEIDER. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 25, 1934, pages 486-488. The part was molded on stripping plate molding machines. Making pattern plates is discussed at length. Method, as applied in the author's foundry gave castings that were true to dimensions. GN (3b)

6

Production of Alloy Steel Castings. A. W. GREGG. *Foundry Trade Journal,* London, Vol. 51, Aug. 16, 1934, pages 102-103. Exchange paper presented before the 10th Annual Meeting of the Bureau of Steel Manufacturers of Australia. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 514. AIK (3b)

7

Formation of Graphite Nuclei in Cast Iron. *Foundry Trade Journal,* Vol. 50, June 14, 1934, page 384. Extended abstract of article from *Archiv für Eisenhüttenwesen.* See *Metals & Alloys,* Vol. 5, Oct. 1934, page MA 473. AIK (3b)

Influence of the Phosphorus and Silicon Contents on the Fluidity of Cast Iron (Invloed van het fosfor—en siliciumgehalte op de dunvloeibaarheid van gietijzer). IR VAN DER VELDEN. *De Gieterij,* Vol. 8, June 1934, pages 79-81. From an article by R. Berger in *Bulletin de l'Association technique de Fonderie,* Dec. 1933. Reviews Berger's conclusions as well as those of W. West in the same issue. Discusses the bases of both methods. See "The Study of Pourability of Cast Iron," *Metals & Alloys,* Vol. 5, June 1934, page MA 253. MPW (3b)

8

The Pipe Foundries of the Staveley Coal & Iron Company Limited. *Foundry Trade Journal,* Vol. 51, Oct. 11, 1934, pages 225, 226, 230. Vertically cast pipe foundries are described. AIK (3b)

Research on Cast-Iron. *Engineering,* Vol. 138, Nov. 30, 1934, page 600. Brief summary of the annual report for the year ending June 30, 1934 of the British Cast Iron Research Association. LFM (3b)

9

American Duplex Process for Cast Iron. *Engineer,* Vol. 158, Nov. 16, 1934, page 481. A new type of manufacture has been developed for making railway car wheels. A combination of a hot-blast cupola with a hot-blast air furnace is used which improves the physical properties 10 to 20%. This improvement is due to the superheating with removal of non-metallic inclusions and deoxidation and degasificition of the metal. The metal is heated to 2900° F. before pouring which produces a highly homogeneous metal. LFM (3b)

10

Practical Bath Manufacture. *Engineer,* Vol. 158, Dec. 7, 1934, page 577. Discusses the proper preparation of iron in the cupola. Concrete blocks are used instead of the usual wooden patterns and the cupola iron is cast into the top of the mold. Slight cracks and blemishes are removed by welding. The bath tubs are annealed before the enamel is applied. LFM (3b)

4. WORKING

Research on Plastic Deformation of Metals (Forschungen über die bildsame Verformung der Metalle). F. KÖRBER. *Die Naturwissenschaften*, Vol. 34, Aug. 24, 1934, pages 565-569. Lecture at the Annual Meeting of the Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften, reviews the investigations at the Kaiser Wilhelm Institut für Eisenforschung in the fields of plastic deformation of metals. The mechanism of deformation and the measurement of the stress distribution at the surface of the material in contact with rolls are discussed. Based on these determinations the displacement of the work can be derived. The energy consumption in technical shaping processes (rolling) is dealt with. See also *Metals & Alloys*, Vol. 5, Mar. 1934, page MA 104. EF (4)

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Bearings of Artificial Plastics in Place of Metal and Pockwood Bearings (Lager aus Kunstharz—Pressstoff an Stelle von Metall- und Pockholzlagern). F. KIEL. *Stahl und Eisen*, Vol. 55, Jan. 31, 1935, pages 105-107. Mention is made by tradename of several pressed plastics which have been used as bearings particularly on rollways of rolling mills. They are cheaper than pockwood bearings, when a large number of similar bearings can be made. Experience on the rollways of a thin sheet mill is cited indicating a reduction of the power consumption. Details are given on the design of the bearings and on the method of lubricating with water. SE (4a)

The Manufacture of Tinplate. GEO. A. V. RUSSELL. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 86-87. The application of recently developed rolling technique is reviewed. The four-high mill for cold-rolling and the Steckel process of rolling under tension are now favored in British practice. Ha (4a)

Determination of Principal Stresses of Malleable Materials Under Plane Rolling Process. HIROSI YAMANOUTI. *Journal Society of Mechanical Engineers*, Japan, Vol. 37, Nov. 1934, pages 783-793. In Japanese. Paper read before the Special Meeting for the Applied Mechanics of the Society of Mechanical Engineers, Tokyo, Nov. 25, 1933. Investigation to determine the distribution of the principal stresses in the material at the moment of passing through the rolls. The stress intensity on the contact surface is not constant and does not keep the minimum plastic stress intensity. The maximum stress intensity is sometimes about twice the mean stress intensity. Figures gained by calculating the necessary power for the rolling process are compared with measured values. Kz (4a)

76" Hot Strip Mill, Indiana Steel Co., Indiana Harbor, Ind. R. W. DAVIS. *Iron & Steel Engineer*, Vol. 11, Dec. 1934, pages 486-494. Descriptive. WLC (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

Drop Forging Practice. A. M. STEEVER. *Industrial Heating*, Vol. 2, Feb. 1935, pages 65-72. Heating of stock for forging and types of furnaces used are described; in designing forgings, grain flow must be considered. Maximum forging temperature for various metals and physical properties of longitudinal and transverse sections of forgings are given. Cleaning and inspection of forgings are discussed. Ha (4b)

Producing Collapsible Tubes. *Machinery*, London, Vol. 44, Aug. 16, 1934, pages 573-576. Refined tin is melted in gas furnaces at 480°-500°F. and Cu to the extent of 0.5% is added. To produce ingots free from air holes the metal is poured into inclined molds so that the molten tin runs down one side of the mold. Ingots are rolled and slugs punched from the metal strips. Extruding operation and machine used are discussed. Kz (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

Influence of the Reduction in Cross-section and the Die Form on the Internal Stresses and the Strength Properties of Cold-drawn Brass Rods (Einfluss der Querschnittsverminderung und der Düsenform auf die inneren Spannungen und die Festigkeitseigenschaften kaltgezogener Messingstangen). H. BÜHLER & E. H. SCHULZ. *Zeitschrift für Metallkunde*, Vol. 26, Sept. 1934, pages 199-203. The longitudinal, tangential, and radial stresses remaining in the surface and core of cold drawn brass (63% and 58% Cu) rods, 50 mm. in diameter, after area reductions of from 0.25% to 7% were studied by the bore test method of Sachs. With reductions of less than 1%, which produce plastic deformation only near the surface, the core was found to be in longitudinal tension and the surface in longitudinal compression. Somewhat heavier reductions produce tension in the surface and core and an intermediate zone of compression. Reductions sufficient to plastically deform the entire section left the core in compression and the surface in tension. Four die shapes; radius = ∞, 50, 30, and 20 mm. were tested. With light reductions the cylindrical die requires the most power for drawing and leaves the greatest residual stress in the bar, while the die of smallest radius (R = 20) represents the opposite extreme. At higher reductions the dies of intermediate radius consume the least power in drawing and produce rods in the lowest state of internal stress. The smoothest surface was produced by the die of smallest radius. FNR (4c)

Tool Steels. J. P. GILL. American Society for Metals, Cleveland, 1935. Cloth, 6 x 9 inches, 136 pages. Price $2.50 bound, $2.00 paper. Five educational lectures delivered at the National Metal Congress, October 1-5, 1934. The introduction states that these lectures are not intended for the metallurgist or the tool steel expert, but for engineers and shopmen. The latter class may be grateful that the lectures have been printed to allow leisurely study, for there is too much meat in the book to be digested by a novice on mere hearing the lectures or on a casual reading. The book is aimed to help the user rather than the maker of tool steels, since the problems of control of quality are hinted at rather than discussed. The user will find the book of value, as it is compact and up-to-date. It may well follow Grossmann and Bain's High Speed Steels in a study of the subject. The effect of alloying elements, type compositions, preferred heat-treatments and properties of all grades from carbon to cobalt high speed steels, methods of evaluation of quality, tendency toward distortion, etc., are discussed. The author's view of the value and potentialities of high vanadium and the high molybdenum-low tungsten types is frankly given. Not all readers will agree with the author on all points, but perhaps the most valuable feature of the book is the perspective it gives. The comments on the interpretation of deep etch tests are of special interest. Several misapprehensions that can exist because of incomplete statements in or erroneous interpretation of the earlier literature are corrected by casual comment, such as that on the effect of molybdenum on hardenability, on hardening furnace atmospheres and on copper in tool steel, though in the last case there is no explanation why the presence of a little copper, which is stated not to cause red-shortness in carbon tool steel, should be held responsible for it in high speed steel.

The author has done a good job. It is a pity that the publishers did not think enough of the book to provide it with an index. There is not even a table of contents and the reader must become well acquainted with the arrangement of the book before he can use it for ready reference. H. W. Gillett (4c)—B—

A Modern Copper Wire Mill in Italy. E. KAESTEL. *Metal Industry*, London, Vol. 45, July 20, 1934, pages 51-54. A new copper wire mill, electrically equipped, was recently built in Milan. The author describes, somewhat in detail, the process of producing wire from bar material. A number of photographs of equipment are included. HBG (4c)

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4d. Machining

H. W. GRAHAM, SECTION EDITOR

Planing Versus Milling Symposium at 1933 Annual Meeting of American Society of Mechanical Engineers: (1) Economics of Planing Versus Milling. A. C. DANNEKIND. *Mechanical Engineering*, Vol. 55, Nov. 1933, pages 673-676. General Electric Co.'s records indicate that up to about 30 years ago its average machine shop listed as many planers as milling machines, and that starting in 1916, jobs were transferred from planers (of about 6 ft. capacity and smaller) to milling machines. Latter have been developed into several types, each having distinct features. Inherent principle has permitted engineering developments and offered a wide field for exploitation; not so with planer. In attempting to compare true economies, consideration must be given to (1) nature of work; (2) machine operation and maintenance; (3) tool and fixture costs and maintenance. Cost analysis determines whether to use a milling machine with lower direct labor cost and higher tool cost per piece produced, or a planer where exactly the reverse is the case. Nature and characteristics of material are important factors. Castings containing hard spots, blowholes, or sand inclusions usually have more destructive effect on single-point planer tool than on milling cutter. Milling will produce a sufficiently high quality of surface finish. Comparative costs for fixtures for work adapted to either planing or milling should be the same. "In no single instance do our records indicate the changing of a job from a milling machine to a planer for purely economic reasons." Advantage of planer is its broad flexibility; it will always be a real factor. **(2) The Case for Planing.** F. E. CARDULLO. *Mechanical Engineering*, Vol. 55, Nov. 1933, pages 677-681. We should compare only machines of modern design: most planers and many milling machines now in use are of obsolete design. Under favorable conditions, a planer of medium or large size will remove metal from work of suitable size at a faster rate than a milling machine, and less work is expended in removing the metal, because tools of better form may be used, coarser feeds may be employed, planer tool does not distort chips as much, does not cut chips into fine pieces, and does not abrade the work with the chips. With equal workmanship, rigidity, and supervision, generating tools are more accurate than forming tools. Planer generally being used as a generating tool, it will do much more accurate work, thus saving in fitting and erecting, and producing a more useful and longer-lived machine when the work is assembled. Special-type planers have been built in which 40 tools are cutting at one time. In many shops where milling machines are generously equipped with tools and fixtures and intelligently supervised, planer department is grudgingly supplied and receives no intelligent supervision. In field of mass production, especially of small parts, milling machine is superior; on large work, repair and jobbing work, in shops where production of identical pieces is limited to a few at a time, and on accurate work and in the toolroom, planer is usually economically superior. The fields of the 2 machines overlap, even in mass-production work, where planers of special design may be employed, especially in cases where work of great accuracy or fine finish is required. When there is a question as to which should be purchased, the milling planer should be considered: it can do planing, milling, boring and drilling in same setting of work, and combines several advantages of both. **(3) The Case for Milling.** R. E. W. HARRISON. *Mechanical Engineering*, Vol 55, Nov. 1933, pages 682-684. American Machinist's 1930 "Inventory of Metal-Working Equipment" showed 50% of the milling machines in use were installed since 1920, against 30% for planers. It is significant that industries started up during last 20 years have in most instances adopted milling machine as the correct tool for the generation of their plane surfaces. No reflection on ability of the planer mfrs. as the modern planer is in front rank in regard to up-to-date design. Reason for changeover lies in lower production costs. Milling machine has displaced planer on small work; on heavy work, in the majority of cases only existence of previously-bought heavy planing equipment (investment in which having been to a large extent amortized) prevents adoption of the newer process. Records of installation in last 3 years, during which every machine-tool investment was supercritically surveyed, show that industrial preference is overwhelmingly in favor of milling. Paper endeavors to trace underlying reasons. 3 basic considerations are outlined: (1) Is it desired to produce piece at lowest possible ultimate cost? (2) Will selling price permit a production cost other than the lowest attainable with most efficient machine-tool equipment? (3) Is there any unchangeable physical design factor which would preclude work from being handled on one or other type of machine?—design in this case covering metallurgical specifications involving machinability, as well as shape of piece. On assumption that the work must be produced over a period of 5 years at lowest ultimate cost, paper then outlines 14 elements of problem which must be known for an analysis. Relative manufacturing technique is next discussed in detail under 12 headings. Then comes a balance sheet of itemized merits and demerits. **(4) Planing Versus Milling Symposium Discussions.** *Mechanical Engineering*, Vol. 56, April 1934: B. P. GRAVES (page 227) reports "great advantage" of milling machine. He is Director of Design of Brown & Sharpe Mfg. Co. L. F. NENNINGER (pages 227-228) reports that in shops of Cincinnati Milling Machine Co. planing has "to a large extent" been replaced by milling. COLEMAN SELLERS, 3D (pages 228-229) picks flaws in all three papers and strives to reconcile opposite viewpoints. F. E. CARDULLO (pages 229-231) refutes at great length specific statements by Dannekind and Harrison, declaring that "highest grade of milling machines have planed or ground bearing surfaces"; that planers need not take up more shop room; that accuracy of planer is not inferior; that "planer can produce a finish equal to good commercial grinding"; that no hand correction is required after a job is properly planed; that in.^{3} removed per minute is no criterion; that economics of 2 methods had been presented misleadingly by previous authors in that they failed to consider not only cost of operation but value of the completed machine, as in the case of 2 halves of a steam-turbine casing where "milling would be cheaper but the product would be valueless." R. E. W. HARRISON (pages 231, 249) reviews entire preceding discussion and attempts to show that a number of F. E. Cardullo's statements are "largely matters of opinion" by presenting additional data and experiences bolstering his original contentions. Thus a book-length serially-published symposium, followed with interest by the metallurgical industries because it brought out relative merits as never before, finally ends in a draw. MFB (4d)

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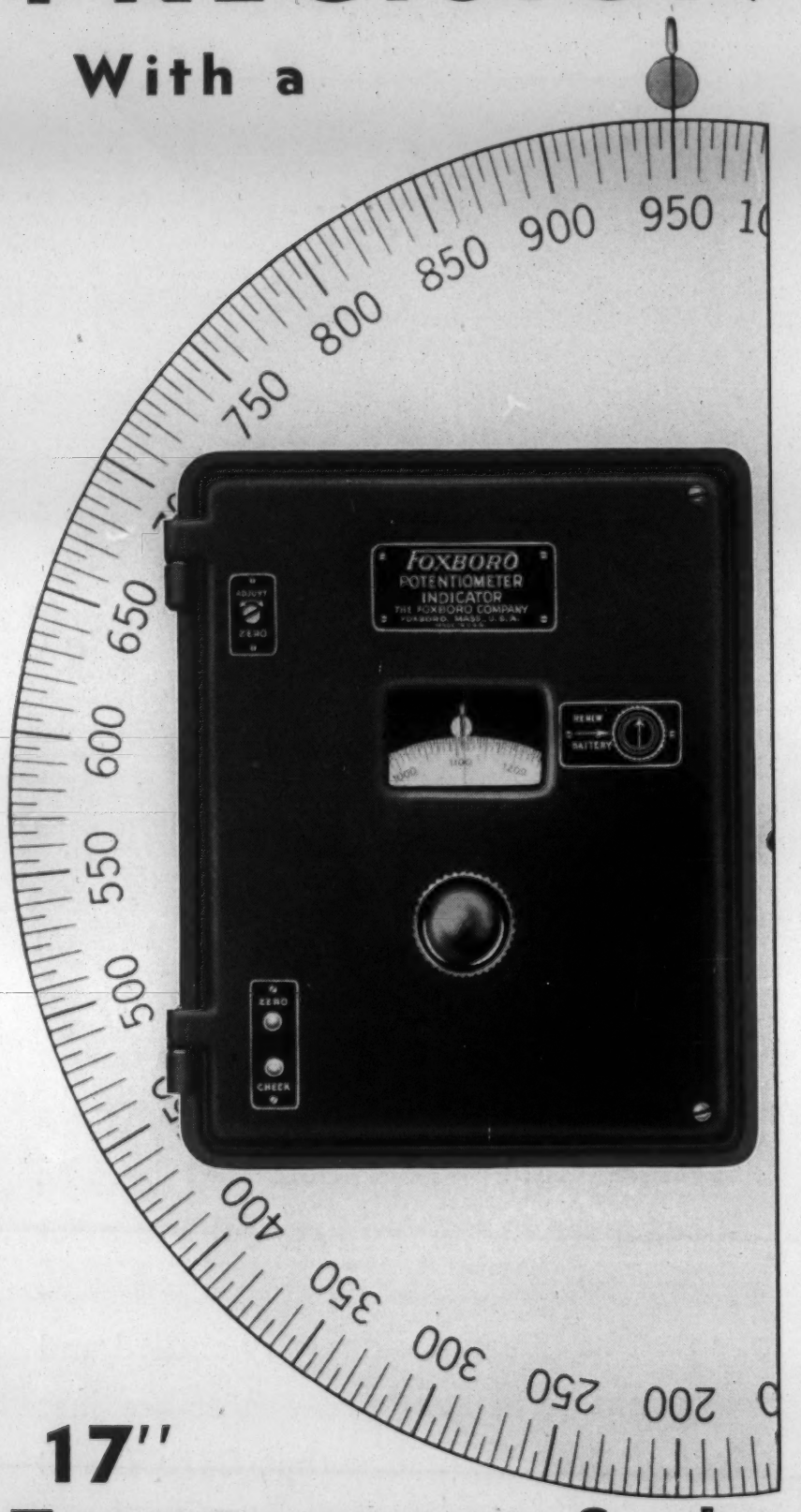

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

5a. Annealing

Annealing of Copper Alloys. R. S. PRATT. *Metal & Alloys*, Vol. 6, Jan. 1935, pages 1-6, 10. 31 references. Various factors in annealing Cu alloys are discussed and data on effect of temperature, amount of work, anneals previous to working, time, grain-size-temperature relations and physical property changes are shown graphically and the various microstructures are illustrated. Table shows compositions, recrystallization range and commercial annealing range for 8 Cu-Zn, 2 Cu-Zn-Pb, 6 Cu-Sn (with Zn or P), 2 Cu-Zn-Ni alloys, Al bronze, 80-20 and 70-30 Cu-Ni and 5 trade marked Cu alloys. Bright annealing technique and equipment are discussed. WLC (5a)

Heat Treatment in a Motor Car Plant. *Machinery*, London, Vol. 45, Jan. 10, 1935, pages 509-510. Heat treating practice described for Dodge plant of Chrysler Corporation, Detroit. Parts are uniformly heat treated by pusher type annealing furnace having heating chamber, 2 holding chambers and 3 cooling zones. WB (5a)

5b. Hardening, Quenching & Drawing

Tempering and Aging of Carbon Steel. G. A. ELLINGER & R. L. SANFORD. *Mechanical World & Engineering Record*, Vol. 96, Oct. 19, 1934, pages 369-376. See "Prolonged Tempering at 100° C. and Aging at Room Temperature of 0.8 Per Cent Carbon Steel," *Metal & Alloys*, Vol. 5, Nov. 1934, page MA 518. Kz (5b)

Finishing Truck Cylinder Liners. W. PAUL EDDY. *Abrasive Industry*, Vol. 16, Jan. 1935, pages 8-11. Cast cylinders are machined and ground to finish. Hardening of the liners by oil quench from 1540°-1560° F. Held at temperature for 32 minutes. Distortion during heating and quench prevented by use of quenching arbor which releases liner after quench. WB (5b)

5c. Aging

Contribution to the Problem of Temper Brittleness (Beitrag zur Frage der Anlasssprödigkeit). W. BISCHOF. *Archiv für das Eisenhüttenwesen*, Vol. 8, Jan. 1935, pages 293-299. In studies of C, Cr-Mn, Ni, and Cr-Ni steels temper brittleness was revealed by impact, repeated impact and bend tests. Physical measurements gave little or no indications. Experiments with quenching temperature, tempering temperature and time, and precipitation or dispersion tests indicated temper brittleness to be associated with the presence of certain Mn and Cr carbides. Temper brittleness could not be ascribed to precipitation effects alone on the basis of these tests. On the other hand the results were explainable on the assumption that 2 carbides may form, a Mn or Cr rich carbide and a Mn or Cr poor carbide. On fast cooling the Mn or Cr rich carbide is retained to lower temperatures at which it breaks down to the Mn or Cr poor carbide. The brittle condition arises when the decomposition rate of the rich carbides is greater than the rate at which the resulting poor carbides are dissolved in the matrix. Other elements and variations in the melting procedure may affect temper brittleness because they change the rate of breakdown or of solution of either of the 2 carbides. SE (5c)

5d. Malleableizing

American Malleable Cast Iron, Its Manufacture in the Electric Furnace (La Malléable Américaine, sa Fabrication au Four électrique). M. GUÉDRAS. *Revue de Fonderie Moderne*, Vol. 28, Dec. 25, 1934, pages 359-360. A rapid method to obtain black core malleable Fe (American) is described. The pieces are heated for 6-12 hrs. in an electric furnace to about 950° C. maximum; cementite is decomposed into its elements Fe and C, the latter being precipitated in the form of graphite. Close temperature control and observation of the proper ratio of the contents of C, Si and Mn is imperative for this malleablizing process. Ha (5d)

5e. Carburizing

Carburizing Practice. JOHN F. WYZALEK. *Metal Progress*, Vol. 27, Feb. 1935, pages 19-23, 64. Describes carburizers in current use and methods for renewal of spent portions. Purchase of grain size controlled steels of S.A.E. 4615 and 3115 grades makes possible heat treating economies by direct quenching. WLC (5e)

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Decarburizing Cast Iron with Hydrogen (Entkohlung von Gusseisen durch Wasserstoff). W. Baukloh, W. v. Kronenfels & H. Guthmann. *Stahl und Eisen,* Vol. 54, Dec. 27, 1934, pages 1334-1336. Hydrogen was passed over gray and white cast-iron for intervals of 7 hrs. at speeds between 100 and 900 cm./hr. and the extent of decarburization observed. Decarburization increased with the rate of gas flow and was at a maximum at 800-950° C. The effect of Si, Mn, Cr, Ni and Co on decarburization was studied. All of these lowered the rate of decarburization, particularly at about 800° C.; a 0.9% Ni addition, however, did not decrease the degree of decarburization, and even raised it at higher temperatures. SE (5e) 6

Valuation of Cyanide Salt Baths (Bewertung von Cyanidsalzbädern). Herbert Müller. *Durferrit Mitteilungen,* Vol. 3, Nov. 1934, pages 47-57. Due to the many advantages that cyanide salt baths offer in comparison with solid case carburizers they find increasing application. In order to have a basis of comparison of the various types of carburizing baths author investigated the remarkable characteristics of such baths and establishes in a similar way as he has previously done for solid carburizing compounds (See *Maschinenbau,* Vol. 11, 1932, pages 55-57) a quality number for cyanide carburizing baths. These quality numbers then permit comparing cyanide baths under technical and economic viewpoints. GN (5e) 7

Practical Experiences with Salt Baths (Praktische Erfahrungen mit Salzbädern). C. Albrecht. *Durferrit Mitteilungen,* Vol. 3, Nov. 1934, pages 58-88. Author first discusses advantages of salt heating treating baths instead of case carburizing in muffle furnaces and stresses points to be observed in this heat treating method. Numerous examples of practical application are given, as heat treating of gears, locomotive parts, piston bolts and spring bolts of automobiles, crank shafts, motorcycle and bicycle parts, parts of typewriters, counting machines and the like, dies, gages, etc. GN (5e) 8

5f. Nitriding 9

Nitriding of Cast Iron. V. O. Homerberg. *Industrial Heating,* Vol. 2, Jan. 1935, pages 19-22, 34. Application of nitriding to case-hardening of cast iron as practiced in foreign countries is reviewed; it is generally used for centrifugally cast cylinder liners (in reciprocal motors and pumps). The most desirable composition for this purpose is total C 2.4-2.8%, Si 2.4-2.8%, Mn 0.5-0.7%, Cr 1.3-1.7%, Al 0.6-0.8%, S and P each below 0.07%; heat-treatment should consist in air-hardening from 1725° F., and then tempering so as to obtain a Brinell hardness between 255 and 320. The difficulties of sand-casting cast Fe containing Al due to a production of a viscous slag are explained; they are overcome by addition of cryolite which is a solvent for Al oxide and protects the melt until it enters the mold. 5 references. Ha (5f) 10

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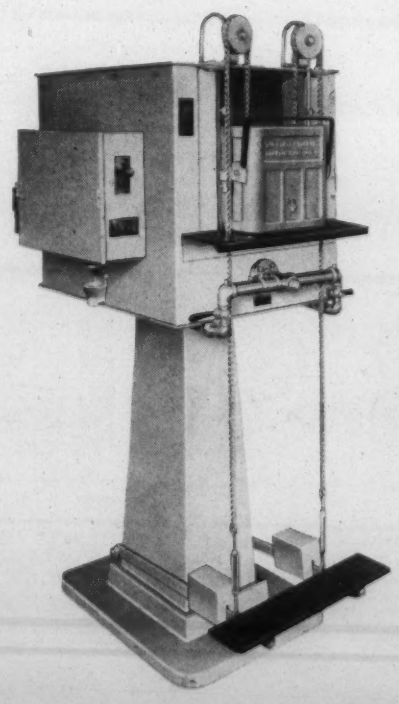

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6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Thermal Conductivity of Refractories Under Operating Conditions. R. H. HEILMAN & R. S. BRADLEY. *American Ceramic Society Journal*, Vol. 18, Feb. 1935, pages 43-48. Test panels 3x3 ft. and 10½ in. thick built into furnace and tested at the same time under as nearly identical conditions as possible. The refractories tested were magnesite, silica, chrome, Mexko, Mizzou and Kruzite brick. Test log is given in part. Temperature gradients determined, also thermal conductivity. Conductivity as a function of temperature is graphed. Errors in conductivity due to use of large chromel-alumel couple used are discussed. WB (6)

Maximum Load for Silit Heating Elements (Höchstbelastung von Silitheizstäben). H. FRIEDRICH. *Elektrowärme*, Vol. 4, Dec. 1934, pages 274-275. The obtainable temperature in the furnace or of the material to be heated for the maximum permissible temperature of the silit heating element of 1450° C. were experimentally determined:

Temperature of furnace or material °C.	surface load of heating element watt/cm².	temperature difference °C.	temperature of-silit rod °C.
1000	30	450	1450
1100	26	350	1450
1200	21	250	1450
1250	17	200	1450
1300	13.5	150	1450
1350	9	100	1450
1400	4.6	50	1450

Suggestions for proper selection of surface load and arrangement of the elements are discussed. Ha (6)

A Tube Generator for Induction Heating (Ein Röhrengenerator für Induktionsheizung). W. FISCHER. *Elektrowärme*, Vol. 4, Dec. 1934, pages 269-273. Principle and arrangement of a high-frequency generator for more than 10,000 cycles/sec. is described. It was developed for laboratory work of melting metals in small amounts where the usual frequencies are too low. The frequency can be adjusted in wide limits by capacity and induction of the circuit. An apparatus for 3.5-4.5 kw. with a crucible of 40 cc. has an efficiency of 90-95% for a pure graphite crucible, for Fe in magnetic state 80-85%, while for metals of good conductivity it is only 25-35%. The highest temperatures can be obtained with graphite and similar materials, the limit depends mainly on the heat insulation; a solid graphite cylinder of 20 mm. diam. could be heated to 2300° C. within a few minutes. The frequency was about 100,000 cycles/sec. Curves of current and voltage are reproduced. Ha (6)

Reaction Properties of Solid Materials. III. The Combustion of Carbon. (Das Reaktionsvermögen der festen Stoffe. III. Verbrennung von Kohlenstoff.) KURT FISCHBECK. *Zeitschrift für Elektrochemie*, Vol. 41, Jan. 1935, pages 60-66. The reactions $C + O_2 = CO_2$, $C + CO_2 = 2\ CO$ are discussed with respect to the reaction velocity, velocity constant and equilibrium relations as a function of the temperature at which the reaction takes place. The burning of C is discussed from the elementary molecular stage and applied to the action of a mass of C during combustion. The effect of the velocity of the gas (air) or CO stream passing through a mass of C is treated mathematically and shown to affect the CO/CO_2 balance. The auto-ignition temperatures of various coals, with and without moisture for various particle sizes were determined and are given in tables. An analogy is drawn between the burning of solid fuel and the dissolution of solids in liquids and the diffusion of the reacting gas or dissolving liquid to the solid is shown graphically to affect the reaction velocity. WB (6)

The Use of Processed Petroleum Coke as a Foundry Fuel. C. B. CARPENTER. *Mines Magazine*, Vol. 24, Nov. 1934, page 9. Physical characteristics of processed petroleum coke and effects of petroleum coke are discussed. Kz (6)

Recent Progress Made in the Refractory Industry (Quelques Progrès récents dans l'Industrie des Réfractaires). G. BATTA & L. SCHEEPERS. *Revue Universelle des Mines*, Vol. 11, Jan. 1, 1935, pages 10-20; Jan. 15, 1935, pages 41-45. An exhaustive discussion of the progress in knowledge, manufacture and application of refractory substances and their testing methods. Principal materials for the manufacture are clays of different kinds; mullite, Al, Mg, chromite ($FeO.Cr_2O_3$), SiC and Zr. Some recent refractory products are: siemensite with a melting point higher than 2000° C., Mg orthosilicate (43% SiO_2, 57% MgO), 1925°, BeO, 2500°, ThO 3000°; and the following nitrides, carbides and borides:

TiC m.p. about	3410°	ZrN m.p. about	3360°
ZrC	3805	TiN	3220
HfC	4160	TaN	3255
NbC	3770		
TaC	4150		
Mo_2C	2960	WB	3265
MoC	2950	ZrB	3195
W_2C	3130		

These materials are used for their great hardness, e.g. as furnace electrodes, as well as for their refractoriness. The manufacture of these products and methods and equipment for testing their properties are described in full. 58 references. Ha (6)

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Electrolytic Production of Beryllium.
The Influence of Bath Composition and Bath Temperature on the Stock-Goldschmidt Siemens & Halske Method for the Production of Beryllium.
Physical and Chemical Properties of Beryllium.
The Production of Electrolytic Deposits of Beryllium by High Temperature Electrolysis.
Direct Electrolytic Production of Beryllium Alloys.
The Structure of Beryllium-Copper Alloys.
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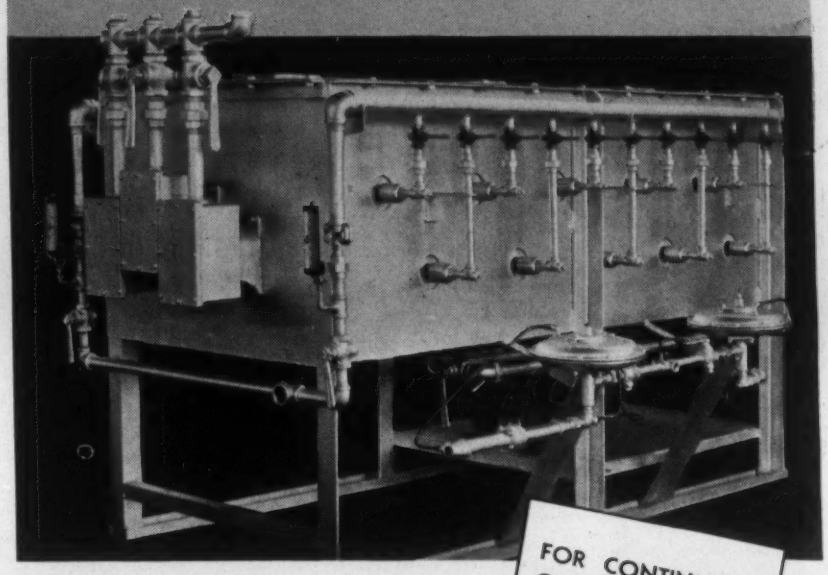

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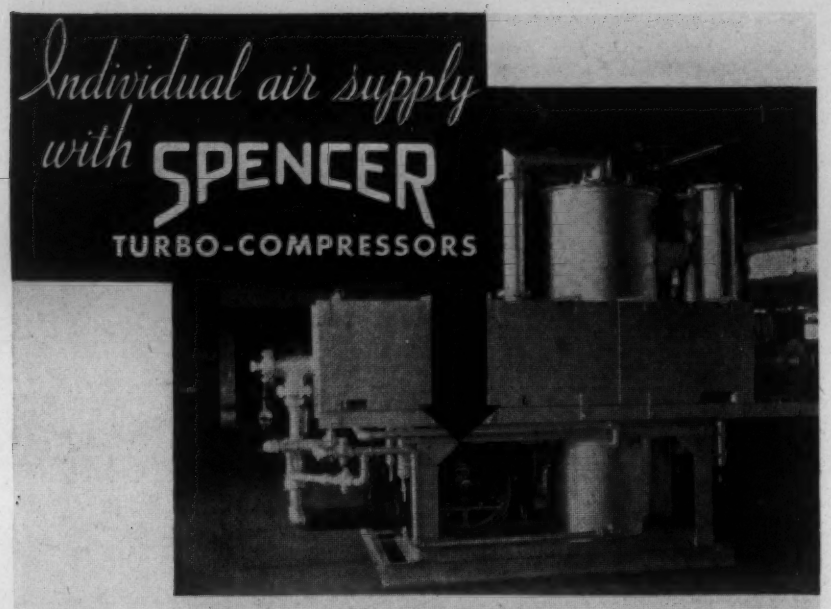

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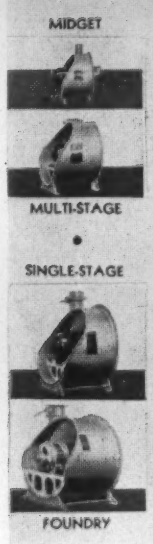

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Lining of High-Frequency Furnaces (Die Zustellung von Hochfrequenzöfen). *Montanistische Rundschau*, Vol. 27, Jan. 16, 1935, pages 1-3. A difficulty with high-frequency furnaces is the short life of the lining. Acid lining is most common in the steel plants on the Continent, while in England the basic lining is most frequently used. The article deals mainly with the English practice. Two
1 types of lining are most common in England, the Rohn lining, which is tamped and sintered in place, and a lining of unburned bricks, with tight groove and tongue joints. One of the most common reasons for failure of the first type of lining is improper mixture of the mass. Many plants use acid linings for certain purposes only, such as the production of W steels, and basic linings for other products,
— such as high Mn or high Cr steels. The longest service obtained for acid lining is 247 charges. Corrosion at the slag line is entirely avoided in the 3-phase coreless induction furnace of Rohn and Hessenbruch, in which the slag is not forced against the furnace lining. The part of the lining which is above the bath is often weak because the sintering is less intense at that point. This may be counteracted
2 by adding some low melting component to the mass used for that part of the lining. By making the first charge extra large a better sintering of the lining above the regular bath surface may also be effected. Thorough drying of the lining before the furnace is used is also of importance, to prevent destruction of the coil insulation. At one plant the life of the lining was increased 50% by cutting
— out the fluorspar in the charge. BHS (6)

High-Frequency Induction Furnaces (Le Four à Induction Haute Frequence). L. LEPRÉVOST. *Revue de Fonderie Moderne*, Vol. 28, Dec. 25, 1934, pages 351-354. The principal characteristic of a high-frequency induction furnace is
3 that it is ready, at any time and without preparation, to supply a mathematically defined composition of metal at the desired temperature, even in amounts much smaller than the full capacity of the furnace. Besides, it can be used for very different metals and alloys if only small amounts of each are required at a time, as in small foundries. Methods of producing malleable Fe, special pearlitic and
— austenitic cast irons, steel for castings, alloys of steel with Ni and Cr, are described. The economical operation is particularly stressed. Ha (6)

Fundamentals, Development, and Examples of Technical Combustion Calculations (Grundlagen, Entwicklung und Beispiele feuerungstechnischer Berechnungen. I. Teil: Grundlagen und Aufbau der Formeln aus den Stoffbilanzen). H. SCHWIEDESSEN.
4 *Archiv für das Eisenhüttenwesen*, Vol. 8, Dec. 1934, pages 231-238. Material balances for theoretical, complete, and incomplete combustion are set up and formulae derived for the amounts of air required and used and of the amounts of exhaust gases and other combustion products. The effect of charging, decarbonization,
— scaling losses, deoxidation, and drying, are also considered in the calculations. SE (6)

Heating Element Technique in Industrial Furnaces (Der Stand der Heizkörpertechnik in Industrieöfen). L. MOENNICH. *Elektrowärme*, Vol. 5, Jan. 1935,
5 pages 15-17. Materials at present available for heating elements for electric industrial furnaces are reviewed, especially for producing high temperatures up to 1350° C., for which alloys of Cr, Al and Co are employed. The influence on furnace design of these materials is discussed and the greater life of furnaces due to better heating elements pointed out. Ha (6)

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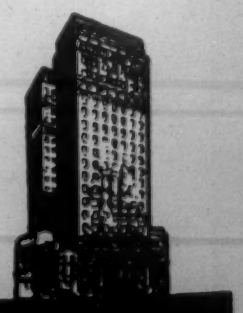

HOTEL ADELPHIA
CHESTNUT AT 13TH STREET

Life of Open Hearth Bottoms. A. KULBERG & G. LYAVDANSKI. *Domez*, No. 10, 1934, pages 14-22 (In Russian). Life of bottoms in Russian plants is one to two years or less. They are made by slagging the brickwork of the bottom with open hearth slag and sintering dolomite magnesite mixture in layers about 40 mm. thick on top of it. After a layer of this mixture is sintered, slag is added to the furnace to saturate it. The total thickness of the sintered bottom varies between 100 to 250 mm. Two bottoms through which the heats ran away and one sound one were investigated. The composition varied widely both in different bottoms and in the portions of the same bottom. No difference in this respect was observed between good and bad. FeO content of the bottoms varies between 7.22 and 37.12%; SiO_2 between 5.15 and 15.40%. The upper portions of the bottom consisted of garnet, $Ca_3Fe_2Si_3O_{12}$, hypersten, $MgFeSiO_3$ and enstatite, $MgO.SiO_2$. Lower layers contained mostly magnesioferrite, $MgO.Fe_2O_3$. Near brick work the latter carries large amounts of magnetite. Distribution of the constituents was not uniform. Three bottoms were made according to the described practice keeping a temperature record of the sintering. In two of them the temperature was kept above 1600°C., in the third between 1400° and 1500°C. The life of the former is not known; the last failed in 3 months. Another bottom was sintered at 1600°-1700°C. and did not cause any trouble during the first 100 heats. Detailed data are furnished. (6) 1 2

Some Factors Affecting Furnace Heating Practice. R. J. SARJANT. *Transactions Ceramic Society*, Vol. 33, Sept. 1934, pages 331-351. This paper is a continuation of a series of contributions to the Transactions of the Ceramic Society, dealing with various problems of heat flow and heat storage in furnace walls ,and with the control of the thermal properties of refractories. In the present paper the author discusses the flow of gases in furnaces, with special reference to draught losses. Data collected from various sources are presented illustrating the value of the various formulae pertinent to the problem. A chart is included which gives means of deducing the radiation from the products of combustion of British coals in the non-luminous condition. GTM (6) 3

Butane for Tool Dressing. HARRY SHERMAN. *Heat Treating & Forging*, Vol. 20, Sept. 1934, pages 457-458. Discusses advantages of C_4H_{10} over coal for forges. With the gas, heated area is 4 times as large; little time is lost in obtaining proper temperature; many more pieces are heated and dressed; better welding is obtained; extremely high temperature can be obtained quickly and maintained evenly; cost is almost 80% less; and labor saving in time is ¼—½. MS (6) 4

Coreless Induction Furnaces Operating on 60 Cycles. HANS DIERGARTEN. *Metal Progress*, Vol. 27, Jan. 1935, pages 42-44. Describes the features of furnace constructed by Heraeus Vacuum Melting Co., Hanau, Germany. Normal line frequencies are used without rotary converter or Scott connections, large surface shallow bath with depressed center, absence of slag line cutting of lining and increased speed of reaction by heating of slag are obtained in this furnace. In a 2T furnace C was reduced 1.00% to 0.04% and S from 0.060% to 0.020% in 40 min. Diagrams and photographs indicate features of design and character of swirling action of metal. WLC (6) 5

Reliability of Thermal Conductivity Measurements of Refractory Brick. J. B. AUSTIN & R. H. H. PIERCE, JR. *American Ceramic Society Journal*, Vol. 18, Feb. 1935, pages 48-54. Wilkes type apparatus, Globar furnace used for tests of conductivity of silica brick, silica and fireclay splits. Instead of water-cooling Globar terminals, strips of 25-27 Cr, 12 Ni steel are connected to terminals and perforated brass radiator. Higher temperature possible in this way, top surface of samples could be raised to 2600°C. in the furnace. The same test was made with a number of the same bricks and percentage deviation from average was less than 5%. Change of conductivity with temperature plotted for 3 commercial grades of silica brick, also splits. Reproducibility of thermal conductivity for duplicate test of same brick ± 5%. Difference in values obtained by various laboratories due to use of different methods. WB (6) 6

Town Gas in the Steel Industry. H. ALEX. FELLS. *Gas Journal*, Vol. 206, May 30, 1934, pages 587-603; Vol. 207, July 4, 1934, pages 36-39. Includes discussion. Paper presented before Institution of Gas Engineers, July 1934. See "The Use of Town Gas in the Steel Industry," *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 566. MAB (6) 7

Rim-Element Electric Furnaces for High Temperatures. H. MASUKOWITZ. *Metal Industry*, London, Vol. 45, July 6, 1934, pages 11-15. A translation from *Elektrowärme*. See "Furnaces for High Temperatures," *Metals & Alloys*, Vol. 5, June 1934, page MA 260. HBG (6) 8

Heating by Induction (Le chauffage par induction). *Journal du Four Electrique*, Vol. 43, Dec. 1934, pages 437-438. Generalities. JDG (6)

Melting Furnaces for Foundries (Smeltovens voor metaalgieterijen). IR VAN DER VELDEN. *De Gieterij*, Vol. 8, Jan. 1934, pages 2-6. Factors which permit a choice between different types of furnaces, types of fuels used, the way in which fuels may be saved as for example, pre-heating and recuperating of heat, and the economic factors are summarized in this comprehensive study which is illustrated by a table in which these factors are tabulated for different localities in Holland. MPW (6) 9

High-Frequency Electric Furnaces. T. SWINDEN. *Iron & Coal Trades Review*, Vol. 130, Jan. 11, 1935, pages 83-84. Progress made in high-frequency furnace practice in 1934 for the manufacture of high-grade steel is reviewed. Some test results of the properties of such steels are given. Ha (6)

The High Frequency Induction Furnace in the Metallurgical Research Laboratory. W. W. STEVENSON. *Industrial Chemist*, Vol. 10, Dec. 1934, pages 486-490. Practical aspects in the operation of a 35-KVA. Ajax-Northrup Spark-Gap type induction furnace for making special alloy steels are discussed. Data are given to show the usual metal losses encountered with various alloy additions when fireclay, sillimanite or magnesite crucibles are used. Physical properties are given to show the similarity of experimental steels to production steels. RAW (6) 10

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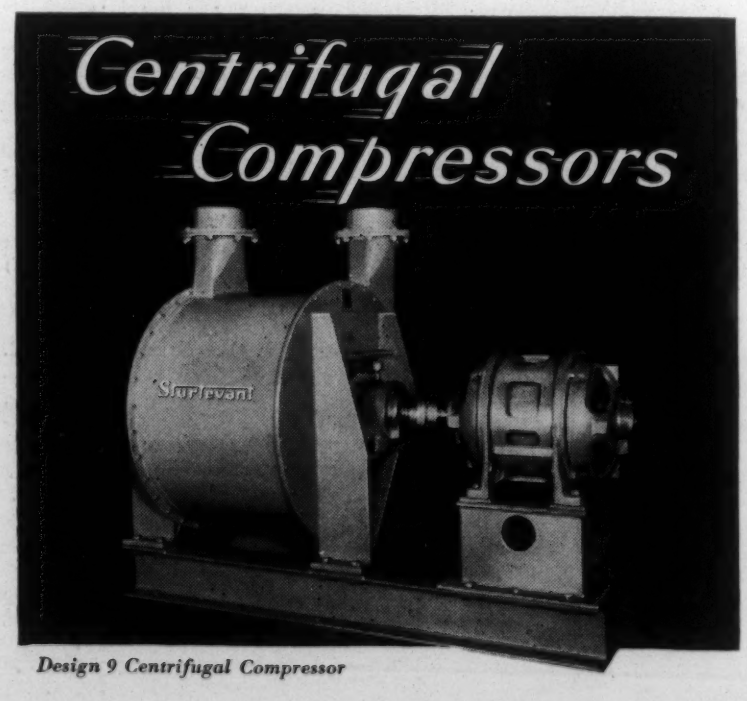

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7. JOINING

7a. Soldering & Brazing

C. H. CHATFIELD, SECTION EDITOR

Tough Machine Parts Copper Brazed in Electric Furnace. H. E. SCARBROUGH. *Metal Progress*, Vol. 27, Feb. 1935, pages 44-46. Describes methods of Cu brazing certain sewing machine parts with resulting economies in elimination of machine work and securely fastening parts together. Joints made by this method are also stronger and more durable. WLC (7a)

Furnace Brazing of Refrigerator Parts. H. M. WEBBER. *American Machinist*, Vol. 79, Jan. 16, 1935, pages 44-48. Quantity treatment of small parts in a furnace with controlled atmosphere is described. WB + Ha (7a)

Plumbed Joints. WM. MASKERY. *Electrical Review*, Vol. 115, Aug. 24, 1934, page 240. Gives directions for obtaining best results in soldering cable joints. MS (7a)

Solder Fittings Find Wider Use. *Steel*, Vol. 95, Aug. 27, 1934, page 29. Gives several examples of the use of solder fittings for making joints in pipe-lines on various kinds of fabricated assemblies. MS (7a)

7b. Welding & Cutting

Welding of Nickel and Nickel Alloys. HERBERT HERRMANN. *Metallurgist (Supplement to The Engineer)*, Apr. 28, 1933, pages 30-32; *Iron Age*, Vol. 132, Sept. 14, 1933, pages 25-26, 70. Apart from the fact that Ni tends to "work" considerably under local heating and that it passes through a hot-short range between 800° and 1050° C. fused Ni exhibits a great capacity for absorbing many gases, especially H, SO_2, and O which tend to embrittle and weaken the metal, H by separating during solidification, forming porous welds, S and O by combining with Ni, forming sulphides and oxides which precipitate in the grain boundaries lowering strength and ductility. O, up to 0.214% is easily soluble and should be injurious only above this point. Nickel sulphide is not dissolved by Ni and separates in the grain boundaries. Oxy-acetylene welding is the only process now available for welding Ni although oxy-hydrogen welding may be applied to the "hammer-welding" process. Sulphur-free acetylene must be used in welding Ni and its alloys since S as low as 0.005% will render the weld brittle. A slightly reducing flame must be used. Mn is the deoxidizing agent generally used in the welding rod and the total content of Mn in the welding rod and the metal should not exceed 0.3%. If Mg is added to the welding rod a correspondingly smaller amount of Mn should be present. For fluxes, borax alone is not recommended, a better flux is a borax-boric acid mixture. Due to expanding and contracting, the material should not be fastened rigidly while welding. Wherever possible, the welding seam should be hammered in order to refine the grain and improve the strength and ductility of the weld, the increase in strength generally amounting to 25-30% and in certain instances 75%. In hammer-welding the temperature should be about 1000°C., the anvil being maintained at 800° C. The Ni-rich alloys, such as Monel metal, are welded similarly to Ni except that they are easily overheated and hence particular attention must be paid to the welding flame. VSP+VVK (7b)

Bronze Welding with the Oxy-Acetylene Flame. A. B. KINZEL & A. R. LYTLE. *Metal Industry*, London, Vol. 45, July 13, 1934, pages 31-35. Paper presented at the XIth. International Acetylene Congress held in Rome, June 5-11, 1934. Bronze welding is defined as a method of joining high melting-point alloys without fusion of the base metals. The general requirements for practical bronze welding such as proper temperature, cleanliness, and necessity for the proper flux are indicated. It is pointed out that the type of union depends primarily upon base metals and that while the composition gradient between base metals and weld metal is markedly different for steel than for non-ferrous base metals, that the difference is in magnitude only. The superiority of β-brass, such as 60:40 Cu-Zn alloy or Muntz metal, as the best general type of welding rod is indicated. Its advantages are: freedom from hot-shortness, a narrow freezing range, and high-strength as deposited. Its disadvantages are sluggishness in flowing on ferrous base metals, and pronounced zinc-oxide fuming. To correct this some minor changes have been made. The effect of the presence of Sn, Fe, Pb, P, Ni, Ag, Si, and Al are discussed. The necessity for careful supervision in manufacture as well as close chemical control are emphasized. Flame-testing of one end of each coil of rods is recommended. The physical properties of welded metal, including pipe-welds, are discussed. In many instances the welding rod containing Si is superior. The necessity of preheating cast-iron pipe to about 900°C. to remove graphite and proper flame adjustment are pointed out. The disadvantages of the process are: (1) lack of strength of bronze at high temperatures and (2) penetration of steel by the bronze. Precautions recommended to avoid the latter are: (a) avoid subjecting steel to stress while it is in contact with the molten bronze; (b) use as low a temperature as possible and a small tip; (c) avoid puddling the bronze; (d) if it is necessary to reapply bronze, remove the previous deposit and approx. 1/16" of the steel directly below it. The advantages of the process are many. Two examples are the low temperature at which welds are made and the benefit resulting from the addition such as wear resistance. HBG (7b)

Flame Cutting of Steel for Welded Joints. E. J. CLARKE. *Mechanical World & Engineering Record*, Vol. 96, Oct. 12, 1934, pages 337-338. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 17. Kz (7b)

Investigation on the Row Electric Spot Welds. I. M. EROFEEFF. *Welding (Autogennoie Delo)*, No. 9, 1934, pages 15-18. In Russian. Two plates were lapped over and electric spot welded. The plates were made of a steel containing: C 0.2-0.3; Mn 0.65; Si 0.25; P 0.04; S 0.04; Ni 0.25; Cr 0.18%. The tensile strength of this steel was 40-50 kg./mm.², elongation 22%. The plates 50 x 100 mm. were taken from the rolled sheets along the direction of rolling. The plates of different thicknesses were used but individual specimens were made by welding plates of equal or different thicknesses. All plates were sand blasted before welding. Factors affecting tensile strength of the welds investigated were: (1) The thickness of plates, (2) diameter of electrodes, (3) steps of transformer, (4) distance from the center of the spot weld to the edge of the plate and (5) distance between the spot welds. The author concluded that: The areas on which a weld is applied should be free from oxides. The period of welding, i.e. the time in which a current is passed, should be as small as possible. The strength of the weld of specimen made of plates of different thickness was somewhat greater than that of a specimen composed of the plates of an equal thickness. The diameter of the electrode depends on the thickness of plates. Electrodes should be water cooled to reduce their deterioration. The pressure on the electrodes during welding should not exceed 30-40 kg. at a spot. The electrodes should be leveled. The distance between the center of a spot and the edge of plate should be in direct proportion to diameter of an electrode. X-ray examination of the welds revealed the presence of gas bubbles and cracks. It was found also that number and size of cracks are in a direct relation to size of the gas bubbles. Author believes that gas bubbles and cracks are caused by overheating the metal during welding. AIK (7b)

Contribution to the Study of Mechanical Properties of Electrical Spot Welds (Contribution à l'Etude des Propriétés Mécaniques des Soudures Electriques par Points). E. J. L. DUSSOURD. *Bulletin de la Société des Ingénieurs Soudeurs*, Vol. 5, Aug.-Oct. 1934, pages 1391-1419. Lecture before the French Welders' Society. Conclusions of the study are: (1) Welding is obtained by melting. Mechanical strength of welded spot is good so long as melting has been attained. With a steel of 41 kg./mm.² tensile strength, a shear strength of 35-44 kg./mm.² in the as welded condition and 34 kg./mm.² in the annealed condition is obtained. (2) A small shrinkage hole is formed at the central portion of welds. This hole depends upon thickness of sheets to be welded and diameter of electrodes. It has a diameter of less than 1 mm. for a spot of 11 mm. diameter and sheets of 5 mm. thickness. With thin plates, the shrinkage hole is so minute that it can be assumed that it does not exist. When a void is present between sheets during welding, an electrical arc is produced with important displacement of metal which forms a metal crater and there is no strength for the welded spot. (3) This kind of welding can be considered as typical fusion welding since atmosphere does not act and there is no added metal. (4) Maintaining pressure during cooling of welds increases shear strength somewhat. This increase is due to: (a) Keeping up metal contact during shrinkage. (b) Increase of cooling rate. (5) With steels of high C content it is different; an increase of cooling rate tends to harden the metal and it is necessary to have a means of heating welded spots on the machine. This heating improves the tensile strength. For instance with a steel of 0.42 C strength in the as welded condition is 21.5-25 kg./mm.² whereas strength with drawing treatment under the electrodes is 46-50 kg./mm.² (6) Cr-Mo steel with 0.25 C, 0.62 Cr and 0.23 Mo is much better than C steel. It gives a strength of 50-52 kg./mm.² in the as welded condition and 55-62 kg./mm.² after a drawing treatment under the electrodes. FR (7b)

Improvements in the Field of Gas Cutting (Neuerungen auf dem Gebiete des Autogenschneidens). H. HOLLER & R. SCHNEIDER. *Autogene Metallbearbeitung*, Vol. 28, Jan. 1, 1935, pages 1-6; Jan. 15, 1935, pages 17-23. The many uses of gas cutting, procedures, equipment for steel and other metals are discussed and described in detail by illustrated examples. Curves of gas and time consumption as dependent on the purity of the O used in the process are given; both increase considerably with increasing impurity. Ha (7b)

Fabricated Steel Units for Gear Drives. W. C. HAWKES. *Machinery*, London, Vol. 44, Aug. 30, 1934, pages 648-649. Deals with the fabrication of gear wheels, gear housings, and bedplates by means of welding. Standard rolled-steel sections for the arms or single-plate webs instead of arms; hubs are made from forged-steel bars or cast steel if exceptionally large or of special shape, but a steel forging is preferable from a welding standpoint; rims, usually in a medium C steel, are rolled or bent from a strip. To avoid residual stresses the joint of the rim has to be made after the rest of the rim has been welded to the arms or hub. To prevent distortion of gear cases and bedplates due to unrelieved stresses, bending of plates to form corners must be avoided. It is preferable to build up from flat plates, rolled channels or beams or a combination of these. Kz (7b)

Roll-Welding High-Pressure Steam Pipe. GEO. H. HALL. *Machinery*, N. Y. Vol. 41, Feb. 1935, pages 342-343. Procedure of roll-welding 14" steam pipe is described. Ha (7b)

Problem of Copper Welding (Das Problem der Kupferschweissung). MAX GREMPE. *Metallwaren Industrie & Galvano Technik*, Vol. 32, May 15, 1934, pages 213-215. Welding simultaneously at both sides results in great heat concentration in Cu which has a thermal conductivity 5 times larger than Fe. Backside welding also reduces access of O_2 which tends to introduce the detrimental cuprous oxide. The filler rod must melt at a lower temperature than the Cu sheet. Hammering raises the relatively low strength of the weld and adjacent parent metal by 50% while elongation gains 200%. A Ag-bearing filler rod shows good fluidity and reduces the tendency of Cu to absorb H. The Canzler rod contains P in addition to Ag which has also been replaced by Mn or Au. Sheets of 2 mm. thickness are welded on one side only. The welding of 2 mm., 2-8 mm. and larger Cu sheets is fully described. EF (7b)

Welding Stainless and Stainless-Clad Steel. W. J. Wachowitz. *Iron Age*, Vol. 134, July 12, 1934, pages 41-42. Deals with the designing, fabricating and welding stainless steel equipment by the Alloy Products Corp'n, Waukesha, Wis. The development of stainless steel wire and flux is considered essential in fabrication of stainless steel. Stresses importance of producing stainless steel wire with low C in order to eliminate corrosion and brittleness in welds. As to stainless-clad steel, claims it has some advantages over stainless steel for certain applications due to its lower cost and can be worked easier. VSP (7b)

The Melting Process in the Direct Current Welding Arc (Der Abschmelzvorgang im Gleichstrom-Schweisslichtbogen). A. Waclawik. *Elektrotechnik & Machinenbau*, Vol. 52, Nov. 11, 1934, pages 525-529. The influence of the heat developed in the electrode due to its resistance, upon the melting velocity and the effect of voltage distribution over the length of the arc on the melting capacity were investigated. In general, as long as the resistance heat is small, the melting velocity is approximately proportional to the current. The voltage in the arc changes continuously because of the drops of metal transferred from electrode to workpiece. A short arc is always preferable as not only the energy consumption for each lb. of melted electrode increases with the length of the arc but it restricts also the absorption of O and N and burns more steadily than a long arc. The electrode as plus pole gives somewhat better conditions than as negative pole. Ha (7b)

Foundries Accept Welding and Aim For New Goals. Herbert R. Simonds. *Iron Age*, Vol. 134, July 12, 1934, pages 19-23. Essentially a symposium of opinion resulting from a questionnaire submitted to a representative group of foundrymen, welders, and equipment manufacturers. Rolled steel products and castings may be advantageously welded is the opinion of foundrymen questioned. For mass production of smaller parts authorities seem to differ, but all agree that welding as a tool in foundry industry is now an established and essential feature. VSP (7b)

Two New Electrodes. J. H. Patterson. *Welder*, Vol. 6, Oct. 1934, pages 335-337. An electrode was developed especially for making overhead and vertical welds which has the advantage that the electrode tip actually touches the work. A table illustrates in detail preparation of piece, welding procedure, dimensions of welds, and gives test results in detail; composition of electrode is not given. Ha (7b)

Welded Connections on Rails (Les Connexions Soudées sur les Voies Ferrées). Maurice Renriod. *Bulletin de la Société des Ingénieurs Soudeurs*, Vol. 5, Aug.-Oct. 1934, pages 1456-1468. Lecture before the French Welders' Society. Deals with connections made to obtain the electrical return line in the rail. 3 processes are actually used: (1) Oxy-acetylene welding. (2) Arc welding with steel as added metal. Use of one of the processes depends upon local conditions. Oxy-acetylene welding is always possible. When reasonable care is taken there is no danger of crack formation in the rails. Details on the shape of cable ends and technique of welding of these ends with steel or Cu as added metal are given. FR (7b)

Tests on Arc Welding of Non-Ferrous Metals (Essais de Soudure à l'Arc de Métaux non Ferreux. Emile Ribeaucourt. *Bulletin de la Société des Ingénieurs Soudeurs*, Vol. 5, May-July 1934, pages 1315-1325. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 570. FR (7b)

Large Automatic Butt Welding Machine (Eine selbsttätige Grosstumpfschweissmaschine und ihr Entwicklungsgang). E. Rietsch. *Die Elektroschweissung*, Vol. 5, Nov. 1934, pages 201-204. Author discusses development of automatic fusion welding machines in U. S. A. These machines have the following restrictions: they are machines especially designed for certain purposes and only permit welding a certain thickness of material. Both of these restrictions are due to the welding method applied, fusion in cold state of material. Fusion with preheating is required for welding large cross-sections. To this end large automatic fusion butt welding machines have been built. The first of these machines was exhibited at the Leipzig Spring Fair 1932 and permitted the welding of cross-sections of 2500 mm.^{2} The latest type can weld cross-sections of up to 25,000 mm.^{2} This machine including all auxiliary equipment is described in detail. The maintenance of the machine is simple and safe. GN (7b)

Welded Blowers (Geschweisste Ventilatoren). Müller. *Arcos Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1132-1133. In manufacturing the blades of blowers considerable savings can be effected by arc welding due to simplified construction and shorter working time. Welded blades furthermore show better properties as regards dynamic balancing and air flow conditions in comparison with riveted constructions. GN (7b)

Welded Cnostruction for a Rigid-Joint Steel Frame Building. C. & P. Molitor. *Welder*, Vol. 6, Oct. 1934, pages 324-327. Details of design and procedure of electric arc welding of a rigid connection between 2 rolled steel joists without any seating bracket are described. Ha (7b)

Fusion Welding in the Construction of Lime Mill Apparatus (La Soudure Autogène dans la Construction du Matériel d'Usines à Chaux). P. Modro. *Revue de la Soudure Autogène*, Vol. 26, Nov. 1934, page 10. Description of the manufacture of a drum of 3 m. diameter, 16 m. length and 8-16 mm. thickness. FR (7b)

Welded Condenser (Une Belle Construction Soudée). R. Meslier. *Revue de la Soudure Autogène*, Vol. 26, Nov. 1934, page 7. Description and illustration of a condenser weighing 15 tons entirely welded with both arc and acetylene welding made by Pecquet, Tesson & Co. in Crouy (France). FR (7b)

Special Machines Built for Torch Cutting Irregular Sections. *Steel*, Vol. 95, Nov. 5, 1934, pages 29-32. Describes some of the gas-cutting machines used by the General Electric Co., Schenectady, N. Y., in the fabrication of turbines, hydro-electric generators, and other heavy steel structures. Procedure involves a combination of straight gas cutting, and highly accurate flame machining and bevel cutting. Oxygen and ordinary illuminating gas are used. MS (7b)

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CHEMICAL ANALYSIS		PHYSICAL PROPERTIES	
Chromium	.50% to 1.50%	Tensile Str.	65,000 to 75,000 p.s.i.
Copper	.30% to .50%	Yield Point	50,000 to 60,000 p.s.i.
Silicon	.50% to 1.00%	Elongation in 2"	27% to 22%
Phosphorus	.10% to .20%		

MUREX COR-TEN STEEL

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Copper	.20%	Yield Point	73,500 p.s.i.
Silicon	.08%	Elongation in 2"	24.5%
Phosphorus	.035%	Reduction in Area	59.6%

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for NICKEL-CLAD STEEL
(for welding of Nickel side)

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31 and No. 35†.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

FLUXES

* INCO Gas Welding and Brazing Flux for Monel Metal.
** "Cromalloy" Gas Welding Flux is recommended for Inconel.
† For vertical welding.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

INCO welding materials as listed can be obtained through regular INCO sources of supply. *Detailed welding instructions furnished on request.*

1 **Pipe Line Completed by Arc Welding Without Backing-up Rings.** A. F. Davis. *Oil Weekly*, Vol. 75, Oct. 1, 1934, page 33. Butt-welded joints without backing-up rings. A space of 1/8" was left to be sure of penetration to the bottom of the welds. Welds consisted of 3 beads made with 3 sizes of electrodes, first with 5/16" size, second 5/16", finishing bead with 3/8". Kz (7b)

2 **Problems of Welding Technique with Reference to Construction of Boilers and Steam Vessels (Probleme der Schweisstechnik beim Bau von Dampfkesseln und Dampffässern).** Czternasty. *Die Wärme*, Vol. 57, Nov. 10, 1934, pages 767-774. The safety of boiler plant operation largely depends on high-quality welds, the accomplishment of which involves a simultaneous solution of metallurgical, structural and production problems. The metallurgical problems involved reflect the present state of welding and its limits of use. Microstructures and X-ray photographs of welds are shown. Stainless Cr-Ni and low C steel with 15% Al could be successfully joined by pressure welding. Water gas welding is restricted by a C content of about 0.2% max. S and P contaminations are harmful and should not exceed 0.04%. The maximum Si content depends on the Mn content. 0.2% Si are harmless in the presence of 0.9% Mn. Al and Cr are undesirable in water gas weldings since their high-melting oxides interfere with a sound joint whereas the difficulties with Mo and W bearing steels are overcome. Electric resistance welding does not impose so many restrictions on the composition of the parent metal. Gas fusion welding could not meet the demand for stronger welds by raising the C content of the filler rod but 1% Mn yielded the desired strength while Cr, Ni and W often lead to excessive hardness of the weld. Mo exerts a favorable influence contrary to Al. The max. Si content again depends on the Mn content. In arc welding the N_2 content of the open-hearth steel increases from 0.005-0.01% to 0.15% (0.03-0.06% with coated electrodes). The brittleness induced by N_2 shows up especially in notch impact and bending tests. Due to the high temperature of 3800° C., oxide inclusions are inevitable. Coated electrodes with 0.05-0.3% C and 0.5-4% Mn are on the market, but recent electrodes run higher in elements known to raise strength and toughness. Basic and acid coatings are employed, great fluidity being the main object. Additions of charcoal, graphite, starch, cotton are made to offset the C loss. Ti counteracts the detrimental effect of N_2. 3 dozen illustrations show interrelation between design and utilization of welding in boiler construction. Balance furnishes instructions for welding shops. EF (7b)

3 **Large Soap Boiling Kettle Fabricated from Nickel-Clad Steel.** George A. Cardwell. *American Welding Society Journal*, Vol. 14, Jan. 1935, page 24. Method of fabricating, by welding, kettle 15 ft. diameter, 29 ft. high. WB (7b)

4 **Metal Surgery Now Perfected. Important Advances in Welding Technique.** C. W. Breit. *Synthetic & Applied Finishes*, Vol. 5, Nov. 1934, pages 188-192. Claims that "of all recent advances in welding practice, the most important is a British development known as the low-temperature process, which employs a special oxy-acetylene blow-pipe, new fluxes and rods. But it is the particular technique of manipulation that makes it possible for fully fusive and sound welds to be performed at temperatures as low as those employed for brazing." EF (7b)

5 **Progress in Structural Steel Welding in 1934.** O. Bondy. *Welder*, Vol. 7, Dec. 1934, pages 403-408. Interesting buildings and bridges erected during 1934 are described, particularly in Europe. Ha (7b)

6 **Spot Welding of Aluminum Alloys.** D. I. Bohn. *Aviation*, Vol. 33, Aug. 1934, pages 256-258. The peculiar conditions prevailing in spot welding Al as compared with other materials are discussed from electrical and metallurgical viewpoints. A conical shaped tip of hard water-cooled Cu is best suited for all gages of material. Electrode pressures vary from a few hundred pounds for the thinner gages to about 1000 lbs. for strong Al alloys of 1/10" or 1/8" thickness. The natural oxide film must be removed prior to spot welding in some cases due to its greater resistance. Spot vs. seam welding and corrosion protection are also considered. EF (7b)

7 **Recent Developments in the Welding of Aluminum Alloys.** D. I. Bohn. *Iron & Steel Engineer*, Vol. 12, Jan. 1935, pages 16-20. General. WLC (7b)

8 **Discussion of "An Examination of Welds Made under Field Conditions for High Pressures, High-Temperature Steam Stations Piping" by A. E. White, D. H. Corey & C. L. Clark.** H. N. Boetcher. *American Welding Society Journal*, Vol. 14, Jan. 1935, pages 29-31. Welders are trained to prepare welds free from stress concentration using low C rods and oxyacetylene. Electric welding not as efficient at present in preventing stress concentration due to inferior penetration. Use of backing strips and successive beads in electric welds may in future be on par with gas weld. Fatigue properties of welds are tabulated. WB (7b)

9 **Experimental Researches Relating to Specifications of Welding Rods for Cast Iron With Particular Significance to Preheating.** L. J. Tibbenham. *Foundry Trade Journal*, Vol. 51, Aug. 16, 1934, pages 104-106; *Sheet Metal Industries*, Vol. 8, Oct. 1934, pages 599-602. Abstract from a paper presented at the International Acetylene Welding Conference at Rome. Experiments were conducted with a filler rod having a very similar chemical analysis to that of the parent metal. After welding the composition of the deposited rod had changed, the Si and Mn contents having decreased and combined C had considerably increased. In order to produce a softer weld, it was found necessary to increase or decrease certain elements contained in the rod. It is generally advantageous to preheat the entire article to be welded, but, as this is often not practicable, it has been found sufficient merely to preheat a reasonably large area. AIK+AWM (7b)

10 **Artistic Craftsmanship and Acetylene Welding (Das Kunsthandwerk und die Acetylenschweissung).** J. Blümmel. *Autogen Schweisser*, Vol. 7, Sept. 1934, pages 113-117. Deals with the application of the acetylene welding to the creation of objects of art. Possibilities of variation in design and the effective use of different metals are discussed. Kz (7b)

G-E Mercury-Vapor-Steam Plant Fusion-Welded throughout. R. H. Rogers. *Iron Age*, Vol. 133, Mar. 8, 1934, pages 8-11, 58. From a paper read before the joint local sections of the American Society of Mechanical Engineers and American Welding Society in New York. Devoted principally to the A. S. M. E. boiler code welding as applied to boilers, piping and other pressure equipment. Describes the plant built by the General Electric Co. in order to make clear the status of the items coming within the scope of the paper. VSP (7b)

Rate of Consumption of the Low Carbon Steel Electrodes. J. F. NAIMOUSHIN. *Welding (Autogennoie Delo)*, No. 8, 1934, pages 3-5. In Russian. The steel electrodes investigated were of the following chemical composition: C-0.06%; Si-0.04%; Mn-0.3%; S-0.02%; P-0.03%. Bare and coated electrodes were used. Current employed was 145-155 amps. The coefficients of consumption of electrodes; i.e. the weights of electrodes per amp. of electric current used, per hour were found to be as follows: 1

electrodes with lime coating = 10.6g./amp./hr.
electrodes with gray coating = 10.1g./amp./hr.
bare electrodes = 14.1g./amp./hr.

The relation between the electrode consumption, Q_e and weight of metal deposited, Q_w was as follows:

$$Q_w = KQ_e$$

where K:

for lime coating = 0.766
for gray coating = 0.763 2
for bare electrodes = 0.770

In order to simplify calculations it may be accepted that in all cases K = 0.765.
AIK (7b)

Activity and Shop of the Ship Welder (Über die Tätigkeit und Arbeitstätte des Schiffsbauschweisser). R. MALISIUS. *Schiffbau, Schiffahrt & Hafenbau*, Vol. 35, Jan. 1, 1934, pages 8-10. With emphasis on conditions prevailing in ship building, discusses penetration, overhead welding, testing, electric welding vs. gas welding, effect of shrinkage, lining-up of work, welding in shop and on ship. 3
WH (7b)

Should Overhead Welding Be Avoided? (Müssen Uberkopfschweissungen vermieden werden?). R. MALISIUS. *Die Elektroschweissung*, Vol. 5, Oct. 1934, pages 191-192. The difficulties of overhead welding are generally due to the lack of welders trained in overhead welding. Trained overhead welders, however, can make overhead welds that are just as sound and safe as welds made horizontally.
GN (7b)

New Building form Introduced by Mercury-Steam Power Plant. D. A. ALLER. *Engineering News-Record*, Vol. 113, Nov. 8, 1934, pages 585-589. General Electric's new mercury-steam electric generating plant is described. Practically the entire plant, structure and equipment alike, is arc-welded, shop and field, with some of the heaviest details and most complicated connection yet attempted by this means of assembly. 4
CBJ (7b)

Welding a 78-in. Steel Supply Line for Seattle Water Department. G. W. DESELLEM. *Engineering News-Record*, Vol. 113, Aug. 16, 1934, pages 204-205. 29,000 ft. of 78" line was replaced by a concrete-coated all-welded steel pipe. Shop fabrication and welding, inspection and testing, coating, and field welding of the installation are discussed. 5
CBJ (7b)

Built-up Welded Beams (Über zusammengesetzte geschweisste Träger). DERNEDDE. *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1134-1135. In supplementing the former paper on this subject (*Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Aug. 1934, pages 1097-1101) author describes a built-up beam, a welded double T-beam. Author critically refers to some of the statements in former paper.
GN (7b)

Welded Motorcycle Frames (Bogengeschweisste Motorradrahmen). DEMARET. *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1138—1139. Describes the welding of motorcycle frames at a Belgian plant. 6
GN (7b)

Warping and Deformation of Welded-Steel Machinery Parts. W. T. DAVIDSON. *Machinery*, N. Y., Vol. 41, Dec. 1934, pages 234-235. The stresses which produce warping in welded steel parts are discussed, methods and procedure of welding to avoid and control warping, and to straighten pieces that have warped are explained.
Ha (7b)

Actual State of Technique of Electric Welding (État actuel de la Technique de la Soudure électrique à Arc). R. D'ABOVILLE. *Revue Générale de l'Électricité*, Vol. 36, Sept. 22, 1934, pages 403-413. Particular requirements of the electric arc when used for welding, influence of electrodes, methods for steadying current and arc, modern equipment and testing methods for welds are reviewed. 12 references. 7
Ha (7b)

Welding and the Steel Industry. *Oxy-Acetylene Tips*, Vol. 13, Nov. 1934, pages 245-250. The many advantageous applications of oxy-acetylene welding for industrial problems, progress in welding methods and development of alloy steels suitable for welding are discussed. Examples in different fields are illustrated. 8
Ha (7b)

Oxy-Acetylene Cutting of Structural Steel. *Engineering News-Record*, Vol. 113, July 5, 1934, pages 12-14. Recommended practices applicable to the use of the cutting blowpipes in fabricating shops and in the fields are enumerated. Qualification tests for full free-hand manual cutting and guided manual cutting are outlined.
CBJ (7b)

Fusion Welding of Copper (La Soudure autogène du Cuivre) *Cuivre et Laiton*, Vol. 7, Oct. 30, 1934, pages 471-476. Action of O on Cu, of reducing gases on the oxidized Cu, and of As in Cu are discussed and literature on the subject is reviewed. 34 references. 9
Ha (7b)

Welded Trolley Cars for the Tropics (Geschweisste Tropenbahn-Triebwagen). *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1131-1132. Construction and welding of trolley cars used in French Equatorial Africa are described.
GN (7b)

Welded Steel Posts (Geschweisste Stahlmasten). *Arcos, Zeitschrift für Lichtbogenschweissung*, Vol. 11, Oct. 1934, pages 1121-1122. The steel posts described as manufactured by Mitterer Steel plant, Regensburg, Germany, are completely made of welded steel plate. The results of mechanical tests of the post described are discussed. 10
GN (7b)

Cutting tools and dies now can be made of cold rolled stock and provided with hard, tough cutting edges which last longer than high speed tool steel. The cutting edge metal is deposited on the mild steel by arc welding with the new "Toolweld" electrode. Tools so made, also tools of high speed tool steel, can be rebuilt with "Toolweld" innumerable times. The weld metal, as deposited, has a hardness of 55 to 65 Rockwell C. This hardness is retained at relatively high temperatures, up to approximately 1000 degrees Fahrenheit. "Toolweld" metal can be heat-treated in the same manner as high speed steel. The weld metal is of high density, practically free from porosity.

COMPARISON—On a lathe operation, fourteen shafts were turned to a depth of 3/16" for length of 15" by a mild steel tool faced by "Toolweld". Turning at the same speed, only six shafts could be machined 3/16" deep for 12" length by the usual high speed tool before it had to be reground. The tool of mild steel faced by "Toolweld" showed almost no signs of wear, yet it did practically three times as much cutting. On this particular operation, "Toolweld" reduced tool costs 62%.

FREE trial sample of "Toolweld" electrode with complete procedure for application is available upon request addressed to

W-119
THE LINCOLN ELECTRIC COMPANY
Welding Research Division **Cleveland, Ohio**
Largest Manufacturers of Arc Welding Equipment in the World

Oxy-Acetylene Welding and Cutting in Metal Working. W. S. WALKER. *Iron & Steel Engineer,* Vol. 11, Dec. 1934, pages 479-485. Discusses the advantages of welding flame cut parts into an assembly. Flame machine and hard facing with use of torch are described and discussed. WLC (7b)

Correct Application of Weld Seams (Richtige Anwendung der Autogennaht). VALENTIN TRUNSCHITZ. *Autogen Schweisser,* Vol. 7, Sept. 1934, pages 122-123. Application of butt welding in repairing sheet metal parts. Kz (7b) 1

Application of Welding in the Maintenance of Water-Power-Plants (Die Anwendung der Schweissung zur Instandhaltung von Wasserkraftanlagen). J. TITSCHER. *Autogen Schweisser,* Vol. 7, Nov. 1934, pages 150-153; Dec. 1934, pages 165-168. Deals with the application of built-up welding for and welding repair of piping, nozzles, and turbine blades of water power plants. Kz (7b)

High Voltage Carbon Arc Welding of Copper and Its Alloys. C. E. SWIFT. *American Welding Society Journal,* Vol. 14, Jan. 1935, pages 26-29. Arc welding of Cu, bronze, brass, Muntz metal with high tin phosphor bronze rod. High thermal conductivity of Cu and alloys requires very high current arcs. Oxygen pick-up so rapid that weld operation must take a minimum of time. The high voltage carbon arc is necessary to form protective atmosphere of CO_2. Rod of 10.5 Sn, 0.3 P, rest Cu, said to give best weld. Welding speed should be greater than 10"/min. for electrolytic Cu. Deoxidized Cu is safest to weld, no oxide segregations occur. Micros are shown for various welds, indicating O_2 pick-up with poor weld. Data on rod and carbon size for various sheet sizes. WB (7b) 2

Metallic Arc Welding. H. V. STEAD. *Marine Engineer,* Vol. 57, Nov. 1934, pages 320-323. Dealing with factors involved in insuring sound welding, welding technique, electrodes, heat treatment, practical tests, and testing procedure are discussed. Kz (7b) 3

Ship Structural Design. EDWARD F. SPANNER. *Marine Engineering & Shipping Age,* Vol. 39, Dec. 1934, pages 453-455, 467-469. Proposal of changes in design and wider application of welding in construction of ships. Kz (7b) 4

Automatic Arc Welding. I. S. SMIRNOFF. *Welding (Autogenoie Delo),* Oct. 1934, pages 5-7. In Russian. The comparative tests carried out with automatic electric welding vs. hand electric welding showed that the efficiency obtained with automatic welding is from 3.5 to 9 times higher than that of hand welding. AIK (7b)

Design and Development of Simple Welded Parts (Konstruction und Werdegang einfacher, geschweisster Teile). HERBERT SEIDEL. *Autogen Schweisser,* Vol. 7, May 1934, pages 68-71; Sept. 1934, pages 119-122. See also *Metals & Alloys,* Vol. 5, Oct. 1934, page MA 484. Field of application of pipes in construction work for small parts, advantage of their use, and details of construction by means of acetylene welding are discussed. The concluding article deals with the construction of bearings and stands. Kz (7b) 5

Contribution to the Study of Pick up of Phosphorus in Steel Welds from unpurified Acetylene (Contribution à l'Etude de la Fixation du Phosphore de l'Acetylene Impur dans la Soudure des Aciers). D. SÉFÉRIAN. *Revue de la Soudure Autogène,* Vol. 26, Nov. 1934, pages 4-6. Paper read at the 11th Acetylene and Fusion Welding Congress in Rome. June, 1934. FR (7b) 6

Welding the Iraq Pipe Line. WILLIAM SCHACK. *Oil Weekly,* Vol. 75, Oct. 22, 1934, pages 35-36. Some technical details of the job. Kz (7b)

Handicraft and Production by Means of Acetylene Welding (Neuherstellung im Handwerk mittels autogener Schweissung). JOSEF PLATZER. *Der Autogen Schweisser,* Vol. 7, Sept. 1934, pages 118-119. Discussion of production of useful and artistic articles by means of acetylene welding. Kz (7b)

Some Factors of Influence to the Welded Part. MINORU OKADA. *Journal Society of Mechanical Engineers, Japan,* Vol. 37, Oct. 1934, pages 705-710. In Japanese. Paper read before the Meeting of the Western Division, Dec. 14, 1933. Deals with the ability of the welder, material, design, method, tools. Properties of metals deposited by arc welding from various types of electrodes are investigated. Kz (7b) 7

Welded Steel Structures: Recent Developments in Europe. A. RAMSAY MOON. *Welder,* Vol. 7, Dec. 1934, pages 388-396. Some outstanding examples of large buildings and bridges and manner of erection are described. Ha (7b)

Construction of Light Canoes by Fusion Welding (Construction de Canots Légers par Soudure Autogène). P. MODRO. *Revue de la Soudure Autogène,* Vol. 26, Nov. 1934, pages 8-9. Use of welded Al alloy in this construction has allowed a weight saving of 35% about as compared with other types of construction. Alloys used are of the G7 type which is an Al-Mg alloy similar to Duralumin and the Thalassal alloy composition of which is: Al 95.6, Si 0.8, Mg. 2, Mn 1.4, Sb 0.2. Both alloys are readily welded with oxy-acetylene torch following same methods as for pure Al i.e. use of a flux composed of a mixture of alkali fluorides and chlorides and, after welding thorough washing with hot water in order to remove all the remaining flux which may cause corrosion. 2 examples of construction are given: (1) a canoe having 4.8 m. length and weighing 26 kg. is in 3 parts adjustable at will. (2) an out-board motor yawl having 4.8 m. length, 1.5 m. width and weighing only 65 kg. All butt welds are hammered in order to improve mechanical properties of the metal and to rub off the seam and thus allow water to run freely over the yawl sides. FR (7b) 8

How to Cut Maintenance Costs by Arc Welding. ARTHUR MADSON. *Mill & Factory,* Vol. 15, Sept. 1934, pages 50-51, 108. Discussion of examples to illustrate savings by the application of arc welding in repairing broken and worn parts. Kz (7b) 9

Welding in the German Shipbuilding Industry. LOTTMAN. *Welder,* Vol. 7, Dec. 1934, pages 413-414. Comparison of riveted and welded seams; methods and electrode materials used in shipbuilding, especially in war vessels, are discussed. Ha (7b)

New German, Austrian, Belgian and English Specifications on Welded Steel Constructions (In vier Ländern neue Vorschriften für geschweisste Stahlbauten). *Arcos, Zeitschrift für Lichtbogenschweissung,* Vol. 11, Oct. 1934, pages 1123-1126. Discusses the principal parts of the German, Austrian, Belgian and English specifications on welded steel constructions. The various specifications are compared. GN (7b)

Specifications on Welding in Iron-Concrete Construction (Vorschriften über Schweissungen im Eisenbetonbau). *Arcos, Zeitschrift für Lichtbogenschweissung,* Vol. 11, Oct. 1934, page 1120. The first draft of the Belgian specifications on the welding of round bars in iron-concrete constructions is given. GN (7b)

Automatic Welding As Applied to Manufacturing Problems (La Soudure Automatique Appliquée aux Problèmes de la Construction). R. SARAZIN. *Science et Industries (Métaux et Machines),* Vol. 18, Aug.-Sept. 1934, pages 243-245. In this part of the article, following points are dealt with: (1) Welding of pieces in 2 halves with bent edges. (2) Angle and overlap welding. (3) Building up of worn parts. FR (7b)

Welding in the Construction of Locomotives and Rail Cars. OTTO BONDY. *Railway Engineer,* Vol. 55, May 1934, pages 144-147. The revolutionary advances since 1930, when electric locomotives with welded frames and buggies were built in Germany, are traced and full structural details on typical constructions are given. Special chapters deal with shrinkage stresses and testing of welds by radiographical means. WH (7b)

Electrically Welded Railway Bridges. OTTO BONDY. *Railway Engineer,* Vol. 55, Sept. 1934, pages 277-281. All new railway bridges in Germany are of the plate girder type which can now be adopted for any desired span, whereas there is still much uncertainty as to the reliability of welded lattice railway bridges under repeated loading. Three methods of loading for fatigue tests are illustrated by reference to a practical example. Test data are tabulated. Detailed information is given on typical German all-welded bridge constructions of recent years. States that X-ray examination is at present the method of predominant importance, if not the only method of practical value, in railway bridge construction. WH (7b)

Electric Welding Laboratory at Hamburg (Das Elektro-Schweisslaboratorium der Technischen Staatslehranstalten zu Hamburg). GUSTAV WROBBEL. *Schiffbau Schiffahrt & Hafenbau,* Vol. 35, May 1, 1934, pages 86-87. Describes and illustrates the Electric Welding Laboratory at Hamburg, which is "outstanding in Germany and unsurpassed abroad." WH (7b)

Modern Welding Methods in Railroad Maintenance. R. P. WINTON & J. A. WILLSON. *Electric Journal,* Vol. 31, July 1934, pages 272-273. Use of a portable welding machine consisting of a 60 h.-p. 1500 r.p.m. six-cylinder gasoline engine, a 300 amp. 40 volt variable voltage welding generator, and a 7.5 kw. 125 volt auxiliary generator in railroad maintenance work is described. CBJ (7b)

Rolled Steel Now Fabricated by Flame Cutting Process. *Steel,* Vol. 95, Nov. 5, 1934, pages 54, 56. From "Oxy-Acetylene Cutting," a booklet prepared by the Oxy-Acetylene Committee of the International Acetylene Association. MS (7b)

Bronze Propeller Repaired by Electric Arc Welding. *Welder,* Vol. 6, Oct. 1934, pages 333-334. Eroded places of 2 propellers of bronze of 35 tons/in.^{2} tensile strength were built up by a d.c. electric arc with special manganese bronze metal core electrodes. The weld was hammered as soon as each layer was deposited. Ha (7b)

The Welding of Steel Underframes for Railway Rolling Stock. *Welder,* Vol. 6, Oct. 1934, pages 330-332. Details are described and illustrated. Ha (7b)

Works and Researches in Welding (Travaux et Recherches en Soudure). *Revue de la Soudure Autogène,* Vol. 26, Nov. 1934, page 9. (1) Pick up of N by welds: This work has been going on for 3 years and is about over. Results which will soon be reported deal with causes of pick up and effect of the latter. (2) Added metals for oxy-acetylene welding: Study made to establish specification. (3) Corrosion tests: a very up to date alternate immersion testing machine has been installed at the Office Central de l'Acetylene. FR (7b)

Welding of a Cast-Iron Valve Housing (Lötreparatur an einem gusseisernen Ventilgehäuse). *Der Autogen Schweisser,* Vol. 7, Sept. 1934, page 126. **Welding Repair of a Cast-aluminum Crank Case (Reparaturschweissung an einem Kurbelgehäuse aus Aluminiumguss).** *Der Autogen Schweisser,* Vol. 7, Sept. 1934, pages 128-129. Discussion of two repair jobs where the success depends on the application of the correct welding technique and the selection of welding rods. Kz (7b)

Welding and Surface Hardening of Elevator Buckets (Schweissen und Verstählen von Elevatorenbechern). *Der Autogen Schweisser,* Vol. 7, Sept. 1934, pages 125-126. Manufacture of elevator buckets by means of welding. To increase the life of the buckets a lip of wear resisting steel is welded along the edges. Good results have been obtained with high Mn steel. When C steel is used, hardening, which may be carried out by means of the acetylene flame, is essential. In case of worn out lips built-up welding to prevent further wear is possible without demantling. Kz (7b)

Fusion Welding of Copper (La Soudure autogène du Cuivre). *Cuivre et Laiton,* Vol. 7, Nov. 30, 1934, pages 519-527. **Electric Welding of Copper (La Soudure électrique du Cuivre).** *Cuivre et Laiton,* Vol. 7, Dec. 30, 1934, pages 579-582. The various welding methods with oxy-acetylene flame and electric arc, electric resistance and by the arcatom process, their characteristic qualities, type of Cu to be used, fluxes, preparation of work, procedures and treatment after welding are discussed in full. 37 references. Ha (7b) 10

Symposium on the Welding of Iron and Steel. *Engineer,* Vol. 158, Dec. 14, 1934, page 601; *Engineering,* Vol. 138, Dec. 14, 1934, page 656. Outline of the subjects to be discussed at the symposium to be held in conjunction with the annual meeting of the Iron & Steel Institute, May 1935. LFM (7b)

8. FINISHING

H. S. RAWDON, SECTION EDITOR

Finishes for Zinc and Aluminium Die-Cast Parts. HERBERT CHASE. *Synthetic & Applied Finishes*, Vol. 5, Nov. 1934, pages 203-205. Zn die-casting alloys containing Sn, Pb or Cd in excess of 0.005-0.007% are subject to intergranular corrosion which may be accelerated by the high temperatures and presence of moisture encountered in baking oleo-resinous finishes. On the other hand Al die-casting alloys successfully withstand any temperature of baking organic finishes and have even been coated with vitreous enamel. Cleaners used in die-castings must be thoroughly washed out or driven out of any surface porosity by raising the temperature above the boiling point of such cleansers; otherwise blistering of the final finish may occur. Zn-base die castings must be coated immediately after cleaning before surface oxidation occurs. An oxide film on Al die castings is not detrimental. The newer synthetic forms of enamel do not peel off on Zn and a single coat is sufficient. Air-dried synthetic enamels on die-castings are definitely inferior to baked types. Spraying, dipping and brushing are used for applying coatings. Opinions are still divided as to whether sand-blasting, scratch-brushing or polishing gives the best adherence. Cellulose lacquers are not recommended for Al and Zn die-castings. The same solvent cleaners may be used on each. Recipes are given. Exceedingly durable and beautiful coatings are produced on Al by anodic oxidation followed by application of aniline dye and by pigment coatings. Anodic oxidation coatings are now widely used on Al pistons to reduce wear and to maintain a continuous film of lubrication oil. Electroplating of Al die-castings is now done successfully, Ni being recommended as the base metal. Solution containing the following in oz./gal. H_2O is recommended: 19 $NiSO_4 \cdot 7H_2O$, 10 $MgSO_4 \cdot 7H_2O$, 2 NH_4Cl, 2 H_3BO_3. Temperature: 90°-95° F; current 15 amps./ft.^{2}; pH: 5.8-6.0. Cr can be plated over Ni from ordinary commercial baths, as can also Cu (acid bath), brass, Ag and certain oxidized finishes. EF (8)

8a. Pickling

Acid-Cleaning Non-Ferrous Metal Components Prior to Applying Organic Finishes. *Synthetic & Applied Finishes*, Vol. 5, Aug. 1934, pages 118-121. The acid treatments discussed aim at (a) final finish by merely removing tarnish or scale, (b) final bright finish of maximum luster (c) general cleaning prior to metal finishing, chemical coloring or opaque organic finish for which luster is unimportant. The various materials are grouped as (1) coppers, brasses, bronzes (2) Al bronze, (3) Ni and cupronickels, (4) Al and its alloys, (5) Zn-base alloys, (6) W and Mo. Thorough degreasing is stressed, hot trichlorethylene vapor being strongly recommended. (1) For slightly tarnished objects 2 baths are preferred with a cold bath intervening and a final cold and hot washing:

	First Dip	Second Dip
H_2SO_4, sp. gr. 1.84	1 part	3 parts
HNO_3, sp. gr. 1.42	3 parts	1 part
H_2O,		1.5 parts

For heavy scales, weak acid cleansers, ammonia or cathodic treatment must be adopted. (2) 20% (vol.) H_2SO_4 at 70° C. for 1 min. succeeds in most cases. A quick dip into a mixture of 3 pts. H_2SO_4, 1 HNO_3 and 1.5 H_2O brightens the surface of Al bronzes. (3) 20% H_2SO_4 is effective if it can be used hot. For cold pickles, HNO_3 is an essential constituent for reasonable rate; for instance 1 HNO_3 : 1 H_2SO_4 : 5 H_2O. Pure Ni responds to these treatments or electrolytic cleaning in a 4 : 1 mixture of glacial acetic acid and perchloric acid. Volts: 20-50; anode, article to be cleaned; cathode, Ni. Monel metal can be pickled in 10% H_2SO_4 or 50% HCl, in either case 2% Na-chromate or ferric nitrate being present to prevent Cu staining. (4) Caustic soda solution (40%, hot) followed by HNO_3 dip is advised. H_2SO_4 solutions yield a silvery brilliance. HF is used for Si and Si-Cu bearing alloys. (5) Strong alkalies or cyanides are to be avoided (die castings). Electro-cleaning in solution of 6 oz. tri-sodium phosphate/gallon H_2O has proved to be very useful. Perfect adherence of subsequent coatings is assured by a dip in cold 2% HCl. (6) HF containing 5% HNO_3 attacks W readily. A dip of a few seconds in molten Na nitrite followed by quenching in H_2O is suitable for W and Mo. EF (8a)

Pickling of Mild Steel Sheets. HAROLD EDWARDS. *Heat Treating & Forging*, Vol. 20, Aug. 1934, pages 393-399. *Blast Furnace & Steel Plant*, Vol. 22, Sept. 1934, pages 505-508; Oct. 1934, pages 577-578, 590. Similar to *Industrial Chemist & Chemical Manufacturer*, Vol. 9, Mar. 1933, pages 79-82. Contains several additional tables, curves, and photomicrographs. See "The Action of Sulfuric Acid and Hydrochloric Acid on Mild Steel," *Metals & Alloys*, Vol. 5, Feb. 1934, page MA 39. MS (8a)

8b. Cleaning, including Sand Blasting

Cleaning Prior to Finishing Done by Machines in the U.S.A.. *Synthetic & Applied Finishes*, Vol. 5, Nov. 1934, pages 196-198. Describes and illustrates modern American machinery designed for proper cleaning of metallic surfaces prior to application of the finish, such as electroplating or an organic coating. The principal uses of these machines are for cleaning screw machine products, bolts and nuts, cartridge cases and clips, cylinder blocks, crankcases, Al jar caps and various elements for radio sets. EF (8b)

Cleaning Castings by Sandblasting. W. E. WARNER. *Metal Industry*, London, Vol. 45, July 13, 1934, page 35. This method is effective in cleaning castings and forgings if proper abrasives and sufficient air pressure are used. Commonly used abrasives are sand grit and steel shot. Steel shot is superior as it is heavier, causes less nozzle wear and concentrates better. Sand must be dried and screened to remove oversize particles. For greatest efficiency, abrasive must flow readily through the nozzle and contain no grains whose diameters are more than 1/3 the diameter of the nozzle. The size of nozzle depends on character of work to be done and volume of compressed air available. The air pressure required depends upon the kind of material to be blasted. Static electricity is occasionally encountered and may be avoided by grounding all metal parts. HBG (8b)

Recent Cleaning Agents in Metal Industry (Die neueren Reinigungsmittel in der Metallindustrie). EDMUND WALTER. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 8, Jan./Feb. 1935, pages 112-117. Cleaning materials and processes occurring during cleaning are reviewed. A mixture of water and soap acts by emulsifying, dispersing or absorbing the grease and dirt. Alkalies are the best cleaners for metal which is to be electroplated, but care must be taken that they are not too strong and eventually attack the metal. Electrolytic degreasing is very effective but has the disadvantage that H developed in the bath might be absorbed by the metal or alloy; especially if the metal contains P or O segregations. Attempts have been made to prevent the adherence of H bubbles to the metal and to remove them quickly from the surface of the bath, but no definite, satisfactory solution has as yet been found. Ha (8b)

Modern Developments in Metal Cleaning. H. LEWIS. *Mechanical World & Engineering Record*, Vol. 96, Oct. 19, 1934, pages 361-363; Oct. 26, 1934, pages 390-391. Covers removal of grease and scale from metal surfaces. Grease can be removed by 2 main processes, either by aqueous detergents or organic solvents. Recent researches on this subject are discussed. Scale is removed by immersion in acid, usually H_2SO_4 and HCl. The application of a 10% H_3PO_4 solution at 80° C. gives Fe a bluish-gray color, due to a film of ferro-ferric phosphate, which is an excellent foundation for paint, and also a good rust preventive. Research on pickling has resulted in the development of inhibitors such as aniline and quinoline. Mechanism of the action of inhibitors is considered. In conclusion electro-cleaners, alkaline for degreasing, and acid for scale removal, are discussed. Kz (8b)

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8c. Polishing & Grinding

Preparation of Grinding and Polishing Wheels (Das Herrichten von Schleif- und Polierscheiben). O. Scholl. *Oberflächentechnik*, Vol. 12, Jan. 22, 1935, page 16. Hints for making such wheels and materials to be used are given. Ha (8c)

Failures in Polishing with Felt Wheels (Misserfolge beim Schleifen mit Filzscheiben). H. Horstmann. *Metallwaren Industrie & Galvano Technik*, Vol. 32, Mar. 29, 1934, page 142. Critical discussion on felt quality, hardness of felt wheel, quality of glue, preparation and maintenance of felt polishing wheels. EF (8c)

Grinding Eliminates Finishing Difficulties on Frame. *Abrasive Industry*, Vol. 16, Jan. 1935, page 12. Inserts of hard Mo steel in a frame caused "chattering" of the cutting tools. Finish cut by grinding with medium grit SiC wheel overcame this difficulty. WB (8c)

8d. Electroplating

The Electrodeposition of Tin from Sodium Stannate Solutions with the Use of Insoluble Anodes. A. W. Hothersall, S. G. Clarke & D. J. Macnaughtan. *Electrometallurgy*, Supplement to *Metal Industry*, London Vol. 44, May 4, 1934, pages 471-473; May 18, 1934, pages 517-520. Abstract of a paper read before the Electrodepositors Technical Society at the James Watt Memorial Institute, Birmingham, Eng., Feb. 22, 1934. The British Non-Ferrous Metals Research Association sponsored the work described at the Research Department, Woolwich Arsenal, by a grant from the International Tin Research and Development Council. The difficulties of obtaining smooth, adherent and non-porous coatings are described. An alkaline sodium stannate solution was used with insoluble anodes. Methods of replenishing the Sn content of the bath, effects of variations in depositing conditions on the characteristics of the deposit, cathode efficiency and the anodic behavior of Sn were investigated. Composition of the solution used and procedure followed are described. The influence of the presence of varying percentages of sodium stannate on the appearance of the deposit is reported. Concentration of bivalent Sn in excess of 0.2 g./l. promoted the formation of small spongy growths, whereas a similar concentration in excess of 0.5 g./l. tended to make the deposit voluminous and spongy. This is attributed to the tendency of sodium stannate to decompose in solution with the precipitation of metallic Sn. The anodic behavior of Sn in an alkaline solution appeared to be dependent on the hydroxyl-ion concentration, temperature of the solution and on the current density. In NaOH solution the presence of neither Na_2CO_3 nor sodium stannate had any marked influence on anode efficiency but sodium acetate tended to improve the anode efficiency and to make the behavior of the anode more constant and reproducible. Ni and Fe were used as insoluble anodes. Ni was practically unattacked and Fe only slightly. The use of insoluble anodes promotes the decrease in Sn concentration and increase in NaOH and Na_2CO_3 concentration of the bath which tend to reduce the cathode efficiency. A full discussion is given of regeneration which can take place in 2 stages:—(1) anodic solution of Sn; (2) oxidation of the sodium stannate formed during stage (1). Although the work has been done on a small scale, the results indicate that for practical purposes a deposit of at least 0.00075" is required for a non-porous deposit. HBG (8d)

Are Edge Anodes of Advantage in Electrolytic Baths? (Sind Kantenanoden in galvanischen Bädern von Vorteil?). Eugen Werner. *Oberflächentechnik*, Vol. 12, Jan. 8, 1934, pages 1-4. The observation that in electrolytic Ni baths with anodes in plate form the edges were most actively dissolved (because the current density is highest there) led to the conclusion that anodes with many edges would be particularly useful and economical in modern rapid-plating processes. However, investigation showed that not the edges but the increased current density at such places produced the good results and that the same result is obtained by taking precautions so that the bath does not become depleted in Ni sulphate when the Ni anode cannot dissolve quickly enough. An edged anode wears and disintegrates much more rapidly than a plate anode, and as the amount of anode present is the determining factor for satisfactory Ni deposition the plate anode is the more economical. On account of the many small and large holes and crevices which form in the edged-anode the current lines are not so uniformly dispersed as is the case with the plate anode, and the increased current dispersion at the edges does not entirely compensate for this. The rate of solution of the anode is of paramount importance; if it does not dissolve at the same rate as that at which Ni is deposited, Ni salt must be added to the bath to prevent it from becoming too acid. In baths operating with high current density, the tendency toward formation of black Ni superoxyhydrate is increased. This in itself is not serious as it can easily be removed by a cold water jet; under this film is the white, hard layer of pure Ni. However, the presence of superoxide, as shown by formation of grooves or channels in the deposit indicates that the anode has become passive and its disintegration follows. This can be prevented by adding about 4 g. $NiCl_2$ or nickelous chloride to 1 l. of bath. The composition of the bath should be adapted to the current density which is to be used; temperature, also, is an important factor. These conditions and their effects are discussed at great length. Ha (8d)

Purification of Electroplating Solutions by Means of a Small Centrifuge (Die Reinigung galvanischer Badflüssigkeiten mittels kleiner Zentrifugen). *Metallwaren Industrie & Galvano Technik*, Vol. 32, June 30, 1934, pages 285-286. In lieu of slowly working gravity separation or filters, centrifuging is recommended. The advantage of continuous automatic operation and small apparatus is claimed for centrifuges running at 15,000-45,000 r.p.m. EF (8d)

8e. Metallic Coatings other than Electroplating

Lead Coating as Protection From Corrosion and the Status of Lead Coating Technique (Die Verbleiung als Korrosionsschutz und der Stand der Verbleiungstechnik). H. M. Forstner. *Oberflächentechnik*, Vol. 11, Aug. 7, 1934, pages 173-176; Sept. 4, 1934, pages 187-190; Sept. 25, 1934, page 201; Oct. 9, 1934, pages 213-217; Oct. 23, 1934, pages 225-227; Nov. 6, 1934, pages 235-237. Properties of Pb and its resistance to corrosion are discussed exhaustively, also the formation of a protective film by the chemical reactions going on in air. The action of water containing O and CO_2 on Pb is represented by the reactions:

$$2Pb + O \longrightarrow 2PbO$$
$$2PbO + 2H_2O \longrightarrow 2Pb(OH)_2$$
$$2Pb(OH)_2 + CO_2 \longrightarrow 2PbCO_3 + H_2O$$
$$2PbCO_3 + 2CO_2 + 2H_2O \longrightarrow \text{soluble } 2Pb(HCO_3)_2.$$

Uses of Pb in chemical industries are reviewed; pure Pb is resistant to H_2SO_4 up to 200° C., at 230° lead sulphate is formed. Addition of 0.2% Cu protects Pb up to 315° C. Internal inter-crystalline corrosion of Pb may result from alternating stresses of long duration, continuous vibration, and simultaneous chemical corrosion. Tests of purity of Pb are described, and the regulations in different countries regarding purity of Pb for technical applications reviewed. Statistics on production and consumption are given. Methods for Pb coating used preferably at present are: 1. Hot lead coating, 2. "Homogeneous" coating, 3. Electroplating. In hot Pb coating the objects are immersed in a bath of Pb with about 10% Sn or Pb with ½% Hg, 1% Zn and 1% Sn, or with additions of Sb or Sb-Sn. Homogeneous Pb coating consists in melting Pb by oxy-hydrogen burner with excess of H on the surface which is sometimes first tinned. Electroplating can be done only in an acidic aqueous solution of Pb, or by fusion electrolysis; for the first, solutions containing fluosilicic Pb, fluoboric Pb with colloids, or perchloric Pb are used. Fusion electrolysis is applied for continuous Pb coating of wires. Spraying of Pb is widely applied. Details are given on these various processes together with literature references pertaining to them, and the basis for selection of a particular method discussed. Of prime importance is the required thickness of the coating. The tensile strength of Pb decreases with increasing temperature as follows:

20° C.	135 kg./cm².
82° C.	80 kg./cm².
150° C.	50 kg./cm².
195° C.	40 kg./cm².
265° C.	20 kg./cm².

The thickness of sprayed-on Pb should be:

for atmospheric rust protection	0.2 mm.
for seawater protection	0.3-0.4 mm.
for diluted H_2SO_4	not less than 2 mm.

It is recommended that spraying be done only on galvanized or tinned surfaces. The influence of surface condition on the adherence of the Pb coating is discussed and methods for treating the surface to improve the adherence are described. Numerous patents and names of firms using certain procedures are cited. Ha (8e)

Protective Metallic Coatings by the Wire-Spraying Process. W. E. Ballard. *Iron & Coal Trades Review*, Vol. 129, Dec. 14, 1934, page 929. Principles of wire-spraying (metal spraying) are outlined and the initial preparation of the surface and the metal-spraying pistol described. Metallic particles produced by the action of the heat and friction of the spraying blast on the wire vary considerably in size but do not exceed 1/100 mm.; although spherical when formed their shape is altered by the resistance of the atmosphere. The speed during their short travel is about 700 miles/hr. It is claimed that little or no oxidation takes place during spraying. Sprayed metals can be polished, ground and turned by ordinary means. When sprayed metal is annealed sufficiently to bring about recrystallization a slight contraction in volume occurs and the structure becomes similar to that of ordinary fully annealed metal. Electrical conductivity of sprayed metal is about 80% of that of the metallic wire. Good adhesion is obtained by suitable initial roughening of the surface to be sprayed, and amounts usually to 5-7 tons/in². The protective value of such coatings is good, especially if the metals used form a strong protective oxide film in air not easily broken, and if broken, reforms easily, as with Al and Cu. Atmospheric and electrolytic corrosion of coatings of Zn, Al, Sn, Ni, Cu, Ag and Au are discussed, and a few practical applications described. Ha (8e)

Manufacture of Lead-Covered Fittings (Ueber die Herstellung von verbleiten Armaturen). Erich Becker. *Werkstoffe & Korrosion*, Vol. 10, Jan. 25, 1935, pages 1-2. Protective coatings for fittings (valves, bolts, etc. of cast Fe, red brass, etc.) are alloys of Pb with Sb; the relative hardness values with different additions are:

Pb%	Sb%	Hardness
100	..	4.2
97.5	2.5	8.4
95	5	15
91	9	15.5
87	13	16.5
70	30	20.3
40	60	24.6
10	90	33.2
..	100	33

Hardness and resistance to chemical attack can be further increased by addition of 1-3% Cu. As all these alloys tended to segregate, the cooling after casting should be as rapid as possible and the pouring temperature as close as possible to the melting point. Directions for preparing the Pb-Sb alloys and casting them around the parts to be coated are given in detail. Ha (8e)

Silver Lining in the Process Industries. *Industrial Chemist*, Vol. 10, Nov. 1934, pages 427-429. Johnson, Matthey and Co., Ltd., obtain 99.97% Ag by an electrolytic process which they use for lining process equipment. Details are not disclosed. RAW (8e)

Sprays Metals to Repair Cavitation Damage. *Iron Age*, Vol. 133, June 28, 1934, pages 15, 76. Procedure of the Metallizing Co. of America to determine the practicability of repairing cavitated water turbine runners by means of metallizing. Experiments consisted in applying 7 different metals to the worn spots. Experiments showed that for repairing cavitation in cast Fe buckets, stainless steel, high C steel, Cu or bronze should be used. Practicability of the process as a whole was regarded as definitely demonstrated. VSP (8e) 1

Diffusion of Aluminum into Copper (Sur la Cémentation du Cuivre par l'Aluminum). JEAN COURNOT & GEORGES MEKER. *Comptes Rendus*, Vol. 200, Jan. 7, 1935, pages 125-126. Details are given showing depth of penetration of Al into Cu at 600°, 700°, 800° and 900° F. and the corresponding structural constituents of the Al-Cu equilibrium diagram. At 900° C., all phases of the Cu end of the diagram up to 50% by weight have appeared. Both electrolytic and commercial Cu were used. FHC (8e) 2

Iron-Tin Alloy in Tin Plate. W. E. HOARE. *Iron Age*, Vol. 134, July 5, 1934, page 30. Abstract of paper read before the British Iron & Steel Institute, May, 1934. See "Tin-Iron Alloy in Tinplate with Notes on some Imperfections," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 486. VSP (8e)

Problem of Metallic Coating of Tubes (Zur Frage der Metallisierung von Rohren). W. G. REENE. *Metallwaren Industrie & Galvano Technik*, Vol. 23, Jan. 15, 1934, pages 33-34. Coating by metal-spraying according to Herkenrath-Schoop, by calorizing and by galvanizing is considered. Points out that difficulties in welding galvanized tubes have been overcome. EF (8e) 3

8f. Non-Metallic Coatings

Lanolin Rust Preventers. C. JAKEMAN. *Engineering Research Special Report No. 12, Department of Scientific and Industrial Research, London*, 26 pages, Second Edition, 1934, 0s 6d. Tests supervised by the National Physical Laboratory, extending over 5 years, to find the best means of protecting against rust the bright steel parts of stored machinery are described. The most satisfactory and economical method found was to coat the metal parts with partially refined lanolin (wool grease product and a waste product of the wool-combing industry). Pure lanolin is too expensive. The method recommended is to dissolve the lanolin in white spirit or solvent naphtha, 7.8 lb. of lanolin to one gallon of white spirit or 8.3 lb. per gallon of solvent naphtha. This quantity, applied to the metal by a soft brush, will cover about 1200 ft.² of surface. The efficiency of these mixtures, and the suitability of the solvents from the point of view of initial cost and safety in use, were demonstrated by laboratory experiments and by tests on sea-going vessels passing through the tropics. Results of laboratory work have been confirmed by treated metals stored over a period of 5 years. Under ordinary storage conditions the recommended coatings give sufficient protection against rusting over a period of 5 years, even when the coated pieces are frequently handled. During storage in a severe corrosive atmosphere, such as in an ammonium nitrate shed, satisfactory protection is given for 3 years, the probable loss being less than 3% if the pieces are not handled during storage. VVK 8f) 4 5 6

Chemical and Electrochemical Surface Treatment of Aluminum (Chemische und elektrochemische Oberflächenbehandlung von Aluminium). W. WIEDERHOLT. *Die Chemische Fabrik*, Vol. 7, Oct. 17, 1934, pages 361-364. Mechanism of the solution of Al in acids and alkalies is discussed. Chemical processes for protecting Al consist in dipping in alkaline salt solution to form a surface coating of insoluble double Al salts. Electrochemical processes consist in anodic treatment in various acids to form $Al(OH)_3$, then Al_2O_3. Properties of the coating can be varied by changing the conditions during treatment. After-treatments are sometimes used to fill the pores. Anodic treatment is used to improve corrosion resistance, hardness and wear resistance, to form a base for coloring, and to produce a surface layer having high electrical resistance. 24 references. CEM (8f) 7

Surface Treatment of Aluminum and Its Alloys by Electrolytic Oxidation (Ytförädling av aluminium och dess legeringar genom elektrolytisk oxidation). TAGE SUNDBERG. *Teknisk Tidskrift*, Vol. 65, Jan. 5, 1935, pages 1-4. Describes the Seo method (Siemens-Elektro Oxydation) developed by Siemens & Halske A.G. and the Eloxal procedure used by Vereinigte Aluminium-Werke A.G. By the Seo process, 4 types of surface deposits can be produced: Seo-X, made by d.c. current, an almost colorless or slightly yellow surface film; Seo-S, a black film, produced with a.c.; Seo-G, developed principally for duralumin, a colorless deposit also produced with a.c.; and Seo-Foto. In the latter case the moist oxide film is impregnated with photosensitive chemicals which makes it possible to use the anodized metal as a photographic plate. A photograph developed on such a plate may be heated to 600° C. without being destroyed. Another process described is an English process (Stuart-Bengough) in which the electrolysis is carried out with d.c. in a bath of 3% chromic acid. Data on corrosion resistance and mechanical properties are given and many technical and commercial applications cited. BHS (8f) 8 9

Iron Scale, a Rust Resisting Pigment (Eisenhammerschlag als Rostschutz-pigment). ADOLF SCHNEIDER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Aug. 25, 1934, pages 1001-1002; *Der Bautenschutz*, Vol. 5, June 1934, pages 65-69. Recent investigations have shown that pigments containing C in oil paints promote rusting while Fe oxides give good rust protection. Iron oxide pigments accelerate drying and reduce swelling; adhesivity and density of protective paints are improved. They can be readily obtained by using iron scale as it is produced in heat-treatment and hot-working processes of Fe; the scale contains between 98-99% Fe either in the form of metal or as $Fe_2O_3 + Fe_3O_4$. By annealing the C in it can be removed. Density of finely ground iron scale is 4.2, it is not soluble in HNO_3, little attacked by other acids, and entirely resistant against alkalis. It can be easily colored by little addition of coloring agents, e.g. white lead, chrome yellow, red lead, etc. As large amounts of scale go to waste every year a great economical advantage is offered by their use in pigments. Comparative tests and several applications are described. Kz + Ha (8f) 10

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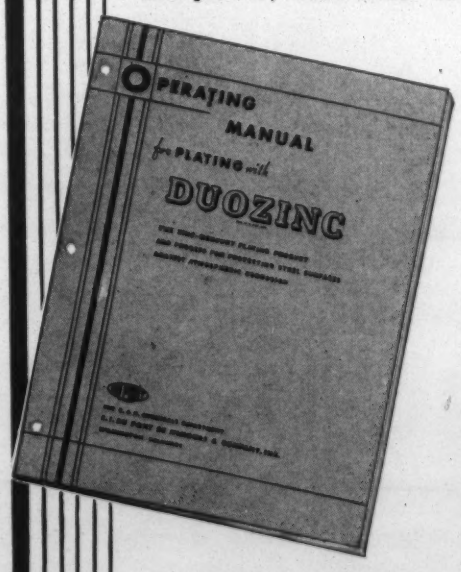

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Inactive State to the Formation of Anodic Film of Aluminum and its Application to the Prevention of Corrosion. AKIRA MIYATA. *Bulletins of the Institute of Physical & Chemical Research*, Tokyo, Vol. 13, Nov. 1934, pages 1299-1327. In Japanese. *Abstracts Institute of Physical & Chemical Research*, Tokyo, Vol. 13, Nov. 1934, pages 76-77. In English. The use of an insulating varnish to protect local areas of Al and its alloys against the formation of the protective anodic film during the oxalic acid treatment is unreliable. However, an inactive state of Al has been discovered which is characterized by an appreciable chemical resistance which, sometimes, surpasses that of the oxide coating formed by the immersion process or the usual electrolytic treatment. The simplest way of producing this inactive state of Al and its alloys is to change the surface metal into crystalline $Al_2O_3.2H_2O$ by dipping into dilute alkali followed by heating in steam. More favorable results are obtained if this process is used to supplement the anodic oxide film formed by electrolytic treatment in an oxalic acid bath. Results are given for the corrosion resistance of the protective film against acids, alkalis and salts. WH (8f)

Coloring of Aluminum (Färben von Aluminium). K. VOLLENRATH & G. LAHR. *Aluminium*, Vol. 17, Oct. 1934, pages 91-92. Recipes for coloring Al with organic substances such as morin and alizarine which form a chemical compound with Al, are given. Obtainable tints are golden yellow, brown, red, bronze and intermediate colors. Other methods mentioned depend on the use of solutions of potassium permanganate. Ha (8f)

Ford's Experience with Alkyd Resin Enamel. J. L. MCCLOUD. *Iron Age*, Vol. 134, Aug. 2, 1934, pages 24-25, 78. Discusses use of alkyd resin enamel by the Ford Motor Co. as a protective coating for steel spoke wheels and other parts, such as interior garnish moldings, radiator grilles and hub caps. It is also used as a body finish. Considers its development and advantages in service. VSP (8f)

Cement Plaster as Rust Protection (Dichter Zementverputz als Rostschutz). WALTER OBST. *Zement*, Vol. 26, Oct. 25, 1934, pages 643-644. States that cement is a particularly suitable rust protection for steel also that "Fe embedded in cement in a rusty state becomes derusted through the action of concrete and assumes a bright metallic surface." American practice of providing oil tanks and boilers with a cement lining and a final sprayed-on (before binding) Al coat is referred to. A recent Swedish development utilizes a mixture of 55 parts of cement and 40 parts of thickened rubber latex as anti-rust coating and a recent Yugoslavian patent refers to paint coatings in which finely ground cement is incorporated. WH (8f)

How Attractive Finish Helps Metal Products Sales. 20.—The Preparation for Paint. *Iron Age*, Vol. 133, June 28, 1934, pages 21-26. Preparation of metal surface for paint or enamel is vital in life and service of coating; the quality of the paint itself may be of less importance in final result. There are two important qualities in preparing for paint: 1) Etching or roughing to provide a foothold for the paint; and 2) Surface insulating, to prevent electrochemical development of alkali. Importance of rust proofing by galvanizing sherardizing, parkerizing, metal spraying and bonderizing is considered and their advantages and disadvantages are listed. Cleaning of non-ferrous metals is also considered. VSP (8f)

How Attractive Finish Helps Metal Products Sales. 24—Painting. R. L. HALLETT & HERBERT R. SIMONDS. *Iron Age*, Vol. 134, Aug. 9, 1934, pages 18-23. Important factors involved in painting metal products are discussed. Paints may be classified as to structures on which they are to be used, as to whether designed to dry with gloss or flat finish, or as to whether intended for exterior or interior exposure. Proper paints for steel bridges, automobiles, tanks, etc. are considered. VSP (8f)

Technical Possibilities for Application of the Eloxal Process (Technische Anwendungsmöglichkeiten des Eloxal-Verfahrens). H. SCHMITT & L. LUX. *Aluminium*, Vol. 17, Dec. 1934, pages 191-195. Hardness and adhesion of the oxide film produced anodically in the eloxal process are extremely good; the former can be varied and it is claimed, may even surpass the hardness of Cr plating. Chemical resistance is excellent after the oxide film which originally is somewhat porous has been made denser by heat treatment. Eloxal films are good electrical insulators and have thermal and radiation properties which make them suitable for heating apparatus. Numerous applications are described. Ha (8f)

Application of the Oxidizing Process in the United States (Anwendung und Verbreitung des Oxydationsverfahrens in den Vereinigten Staaten). *Aluminium*, Vol. 17, Oct. 1934, pages 93-94. Reviews the electric oxidizing processes of Al and its industrial applications. Ha (8f)

On the Regulation of Bath Solution (Oxalic Acid Aqueous Solution) for Electrolytic Oxidation of Aluminum. AKIRA MIYATA & MOTOYUKI KAKEI. *Abstracts from Rikwagaku-Kenkyu-Jo Iho*, Vol. 13, No. 11, Nov. 1934, pages 75-76. In Japanese. The authors studied the restoration of deteriorated oxalic acid baths used for the anodic oxidation of aluminum and have attempted a generalization concerning the restoration of such solutions. Oxalic acid was added in gradually increasing amounts to an old solution and the time-voltage curve determined in each case at 25° C. and 10 mA/cm.², until the original conditions were restored. On the basis of such data empirical equations were drawn up for calculating the amount of oxalic acid needed for restoration. Authors state that in previous report (reference not given) it was shown that the deterioration of a used solution can be represented by the difference (x — y) of the concentration of CaO_4" (x) and H' (y) determined by titration of the solution. Representing the difference (x — y) as "p" and the concentration of H' in a replenished solution by "w," the authors have formulated the following empirical equation for a 2 per cent solution:—

$$w = 2.0 - 0.361\ p + 0.546\ p^2 - 0.08707\ p^3$$

Corresponding equations for 3% and 4% solutions are:—

$$w = 3.0 - 0.823\ p + 0.784\ p^2 - 0.1187\ p^3$$

$$w = 4.0 - 0.556\ p + 0.718\ p^2 - 0.1146\ p^3$$

In using the equation, "p," i.e., (x — y) is determined by titration of the used solution and the equation is solved for "w." Then, w — y = the amount of oxalic acid to be added. All quantities (x, y and w) are expressed in g. oxalic acid/100 cm.³ HSR (8f)

Manufacturing of Vessels, Outside Enameled Inside Nickel Plated (Herstellung aussen emaillierter, innen vernickelter Gefässe). G. HUTH. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Oct. 7, 1934, page 635. Briefly describes a new patented method of avoiding oxidation of Ni parts upon subsequently enameling the outside. GN (8f)

Regulation of Bath Solution (Oxalic Acid Aqueous Solution) for Electrolytic Oxidation of Aluminum. AKIRA MIYATA & MOTOYUK TAKAI. *Bulletin Institute of Physical & Chemical Research*, Tokyo, Vol. 13, Nov. 1934, pages 1285-1298. In Japanese. *Abstracts Institute of Physical & Chemical Research*, Tokyo, Vol. 13, Nov. 1934, pages 75-76. In English. As a follow-up of previous work (See "Researches on the Anodic Film of Aluminum," *Metals & Alloys*, Vol. 4, Aug. 1933, page MA 271 and "Researches on the Anodic Behavior of Al," *Metals & Alloys*, Vol. 4, Sept. 1933, page MA 303) oxalic acid was added gradually to an old deteriorated bath and voltage-time curves for the anodic oxidation of Al were plotted in every case at 25° C. and 10 milliamps./cm.² WH (8f)

Synthetic Resins and their Uses in Finishing Materials. HERBERT CHASE. *Electrical Manufacturing*, Vol. 13, July 1934, pages 23-25. General grouping of commercial resins and lacquers is given and an explanation of their working characteristics and properties for electrical manufacture. WB (8f)

Aluminum Adaptable to Hard Finish. *Machine Design*, Vol. 6, Dec. 1934, page 21. Note on electrolytic treatment of Al pistons (Chrysler process) by immersing the work (anode) for 17 minutes in sulphuric acid at 70° C. An Al-oxide film of 0.00025 in. thickness forms. WH (8f)

The Part Played by Pigments in the Failures of Coats of Paint (Der Anteil der Pigmente an den Anstrichschäden). HANS WAGNER. *Angewandte Chemie*, Vol. 47, Sept. 22, 1934, pages 665-668. The fact is emphasized that the resistance of a paint to weather is not determined solely by the pigment, as is the usual belief, but that, as recent experiments have proved, deterioration of a coat of paint may be due to the vehicle. The pigment may even increase the weather-resistance of the paint. A crystallized pigment of average dispersity has been found superior to amorphous, highly dispersed pigments for weatherproof paints. Ha (8f)

Accelerated Testing of the Resistance of Rust Protective Paints to Sulphurous Acid (Über die abgekürzte Prüfung von Rostschutzfarben auf Widerstandsfähigkeit gegen schweflige Säure). FRITZ-JÜRGEN PETERS. *Farben Zeitung*, Vol. 39, June 30, 1934, pages 675-677. After pointing out the great variety of corrosion tests in SO_2, the author describes experiments at the Chemisch-Technische Reichsanstalt on 9 paint coatings (or combinations) performed under a bell jar in atmospheres containing 2.5%, 1.0% and 0.25% SO_2 by volume. Due to absorption on walls and painted steel panels, the gas was renewed every day. The degree of rusting was determined according to the German standards DVM 3210. 2.5% SO_2 spoiled all samples within a few days. A concentration of 0.25% furnished the best means of distinguishing between various paints applied. Tests with 0.1% and 0.025% SO_2 failed to give conclusive results. The greatest resistance against corrosion was obtained after drying the paint coating for at least 11 days. This is attributed to certain properties of the linseed oil vehicle. Fresh paint coatings deteriorated rapidly. A thin red lead coat used alone or in combination with an outer white lead coat was distinctly superior to a heavy (commercial) red lead coat. Coatings of paints containing Fe oxide were not inferior to red or white lead coats. Over 300 test results are given in chart form. EF (8f)

Coloring of Aluminum and Aluminum Alloys (Färbung von Aluminium und Aluminiumlegierungen). H. KRAUSE. *Mitteilungen des Forschungsinstituts und Probieramts für Edelmetalle*, Vol. 8, Dec. 1934, pages 93-98. Investigation of many coloring methods proved that only few have real industrial value. The best are: for general purposes, permanganate with Cu or Co nitrate; for yellow, sodium bichromate, hydrogen peroxide; iron chloride; for light gray, solution of 10-20% diammonium phosphate and about 5% manganese nitrate. Although fairly satisfactory, they do not equal the anodic oxidation process by which any color can be obtained in a satisfactory way. Ha (8f)

Bituminous Paints for Under-water Use. W. P. DIGBY. *Mechanical World & Engineering Record*, Vol. 97, Jan. 18, 1935, pages 60, 67. Abstract of a paper presented to the South African Institution of Engineers. In certain cases a life of 25 years of internal coatings applied to iron and steel without renewal is a necessary requirement. Features of such coatings, particularly as regards to "cold flow" are discussed. Kz (8f)

The Adjustment of Enamels to Sheet Steel. A. DIETZEL & K. MEURES. *American Ceramic Society Journal*, Vol. 18, Feb. 1935, pages 37-38. A study was made of expansion coefficients of enamels for sheet steel, which included "cover" enamels, upper and lower ground coats and the sheet steel. Effect of iron oxide on coefficient of enamel was determined. Expansion coefficients were calculated for the 3 stages of firing. In stage A, the coefficient is nearly that of the steel, in the finished coat, it varies progressively from that of the sheet steel to that of the cover enamel, the lowest coefficient being that for the cover. Authors show how this information can be used to explain and correct enamel defects. Previous measurements of the coefficient of expansion of sheet steel ground coats are considered to be in error. WB (8f)

Rust-Inhibiting Paint Coatings and Underwater Coatings (Rostschutzanstrich und Unterwasseranstrich). A. V. BLOM. *Farben Zeitung*, Vol. 39, Nov. 24, 1934 page 1192. Summarizes extensive tests in (1) air, (2) water ((a) stationary and (b) flowing) and (3) intermittent immersion; in progress in Switzerland since 1931. Bituminous coatings and synthetic resin varnish were most successful with (2a) and (3). For ordinary weathering, a good quality oil paint on top of basic Pb paints with bituminous emulsion primers yielded good service. Corrosion tests in the Rhine and in the Tessin river did not agree on account of the formation of a natural protective layer of $CaCO_3$ in the former. Bituminous coatings in air sometimes cracked but the red lead primer inhibited any rusting. Oil paints should not be used under conditions like (2a), (2b) and (3). Bituminous emulsions can be applied to moist Fe surfaces without any danger of subsequent underrusting. Fibrous asbestos and cement additions improve the impact resistance of bituminous coatings. EF (8f)

9. TESTING

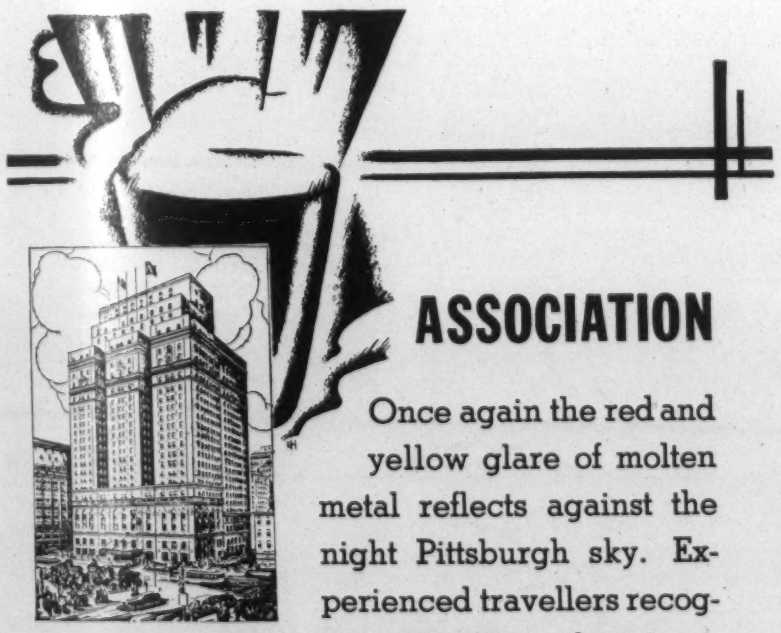
9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Detection of Weld Defects by X-Rays and Their Influence on the Mechanical Properties (Nachweis von Schweissfehlern im Röntgenbild und deren Einfluss auf die mechanischen Eigenschaften). W. TOFAUTE. *Archiv für das Eisenhüttenwesen*, Vol. 8, Jan. 1935, pages 303-306. X-ray radiograms were taken of low C electric arc welded steel plates in which gross weld defects were purposely incorporated. Porosity in the weld greatly lowered the elongation, impact resistance, and bend test values, whereas the tensile strength was lowered only half as much as the elongation. The tensile strength is thus not a reliable indication of the quality of a weld. One could guess from radiograms as to the impact resistance only when very low values were obtained. Defective adhesion at the bottom or side of the vee had a greater effect in lowering the mechanical properties (because of the sharp notch effect) than general porosity. SE (9a)

Relations between Radiographs and the Mechanical Properties of Welds (Beziehungen zwischen Röntgenbild und Festigkeitseigenschaften, ermittelt an Schweissverbindungen). K. WALLMANN. *Archiv für das Eisenhüttenwesen*, Vol. 8, Dec. 1934, pages 243-247. Two-dimensional defects in welds such as harmful cracks may not be detected in radiographs, while less harmful 3-dimensional defects such as blowholes, may be given undue weight because of the appearance of radiographs. Radiographic evidence should be supplemented by mechanical tests. Radiographs may give very useful information in the testing of welds, but their interpretation must be based on extensive data. SE (9a)

Formation of Shatter Cracks in Steel During Heat Treatment (Entstehung von Rissen in Stahl bei der Wärmebehandlung). E. SCHEIL. *Archiv für das Eisenhüttenwesen*, Vol. 8, Jan. 1935, pages 309-314. From the position of shatter cracks in heat treated steel specimens it was concluded that as a rule they form after the last reversal in internal stresses—which occurs almost at room temperature; this holds also for flakes. The shatter-cracks arise out of microscopic cracks, which may remain invisible. In the case of flakes, many micro-cracks grow to larger ones. Repeated hardening is useful for studying micro-cracks. The shatter-cracks occur not immediately after cooling but some time later. Tempering immediately after quenching diminishes the number of micro-cracks and the resulting damage. SE (9a)



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2 — **X-Ray Examination of Gas-Welded, Copper Locomotive Fire Boxes (Röntgenuntersuchungen an gasgeschweissten, kupfernen Lokomotiv-Feuerbüchsen).** W. GRIMM. *Autogene Metallbearbeitung*, Vol. 27, Dec. 15, 1934, pages 385-388. The use of X-ray pictures in determining the most common defects in welds of fire boxes of Cu is discussed and the evaluation of defects explained by photograms. As Cu is more difficult to weld than Fe or steel the X-ray examination should be applied every time until experience has been acquired; then random tests are sufficient. Ha (9a)

3 — **Radiographic Examination of Rivets.** V. E. PULLIN. *Engineer*, Vol. 158, Nov. 2, 1934, pages 429-430. Tests have been developed using either X-rays or radium to examine riveted structures to detect loose rivets. It is somewhat difficult by this method to interpret the radiographs due to the shadows that are cast on account of the complicated shape of the different rivets. When the rivet is loose the radiographs show a light circle which is usually irregular in outline as any gaps existing in the rivet cavity are irregular. Actual radiographs are reproduced some of which are of countersunk rivets where the artificial clearances are uniform to illustrate characteristic shadows, while others are those obtained in actual practice. Radium is used when it is impractical to use X-rays due to the inaccessibility of the rivets to be radiographed. LFM (9a)

4 — **Non-Destructive Materials Testing.** HERBERT R. ISENBERGER. *Aviation*, Vol. 33, Dec. 1934, pages 389-390. Discusses and illustrates the following non-destructive tests with special reference to aircraft construction problems: (1) magnetic analysis by comparison with a standard sample, (2) magnetic analysis by the use of metallic powder, (3) radiographic examination by X-rays and (3) same by γ-rays. Typical magnetic analysis curves from Ni-steel aircraft bolts of normal and low hardness are shown. The chief difficulty lies in the proper interpretation of the wave form of the curves. Limitations are that inspection must be done before installation, that the material must be ferro-magnetic and that no indication of the mechanical soundness of the interior is furnished. The powder method is successfully applied to testing of connecting rod, crank shafts, cylinder blocks and heads, tube welds, propeller blades, hubs and straps. It is admitted that only occasionally defects lying as much as 1/8" below the surface may be found. A novel X-ray outfit weighing 200 lbs. and penetrating 1" of steel in 1 min. is described. Sensitized paper in lieu of films is 1/3 cheaper and exhibits the thinner sections of the casting as well as the thick ones. γ radiology lends itself particularly to field inspection. Pictures of a number of parts or joints can be made simultaneously. EF (9a)

5 — **Simple Method to Distinguish the Common Light Metal Casting Alloys (Einfache Methode zur Unterscheidung der gebräuchlichen Leichtmetall-Gusslegierungen).** M. BOSSHARD. *Aluminium*, Vol. 17, Jan. 1935, pages 13-15. Cast alloys are divided into 5 groups according to their bases: Al-Cu, Al-Zn, Al-Si, Al-Mg, Mg. 4 different solutions are applied to distinguish these groups: (1) 20 g. solid NaOH in 100 cc. H_2O; (2) 1 part concentrated HCl in 7 parts H_2O; (3) 1 part concentrated HCl in 1 part H_2O; (4) 5 g. cadmium sulphate + 10 g. NaCl + 20 cc. concentrated HCl in 100 cc. H_2O. The characteristic reactions on the different groups are described and tabulated and shown in photographs. Ha (9a)

6 — **New Method of Surface Inspection (Eine neue Methode der Oberflächenprüfung).** F. BENNIGSON. *Die Metallbörse*, Vol. 24, June 23, 1934, pages 793-794. An optical method is described, designed for inspection of welded and riveted joints, polished and electrolytically coated surfaces, sheet and tube surfaces by comparison with a standard specimen. Four typical photographs which show simultaneously in the visual field of a microscope the standard and test metallic surfaces are presented. The magnification ranges between 30 and 70. EF (9a)

7 — **The British Steel Castings Industry.** *Engineering*, Vol. 138, Nov. 23, 1934, pages 566. Comments on reaction to reports such as that of the Steel Castings Research Committee of the Iron and Steel Industrial Research Council which stress the defects liable to occur in the manufacture of steel castings. Such reports give the public the impression that intricate sound castings are not made in Great Britain which is far from the actual case. LFM (9a)

8 — **Aluminum Bronze. A Method of Quality Control.** *Machinery*, London, Vol. 45, Dec. 27, 1934, pages 455-459. For plant purposes the micro-structure of different Al-bronze alloys is examined and indicates tensile strength (rupture stress). The tensile strength increases with the degree of fragmentation or grain size, and estimates of $\pm$ 1 ton/in.^{2} are possible by comparison with standard micrographs. Where the material requires heat treatment this method of estimation does not apply after heat treating. A *furnace test* is made by casting a test ingot for elongation of the material, which cannot be evaluated by microscopic means. The use of "cast on" test pieces for elongation and micro examination is advised. WB (9a)

9 — **Container Methods Used in Handling C. & N. W. Stores.** *Railway Age*, Vol. 98, Jan. 5, 1935, pages 7-10. Scrap is sorted and loaded at the point of its origin. At the car yard and in shop the scrap is handled for 36c per ton. Tools are tested for flaws by use of magnetizing current of 50 amp. and iron filings brought in contact with tool after polarizing operation, adhere to region of flaw or crack. WB (9a)

10 — **Non-destructive Testing of Metals by Radiation from Meso-thorium (Die zerstörungsfreie Prüfung von Metallen durch Mesothor-Strahlung).** M. WIDEMANN. *Zeitschrift für Metallkunde*, Vol. 26, Sept. 1934, pages 204-206. A simple technique for the production of radiographs of metal objects using γ radiation from mesothorium is described. Exposures of up to 114 hrs. using 35 mg. of meso-thorium and a film distance of 50 cm. were employed for examining bronze castings of up to 10 cm. in net thickness. The sensitivity in detecting flaws is similar to that encountered in other types of radiography. 5 references. FNR (9a)

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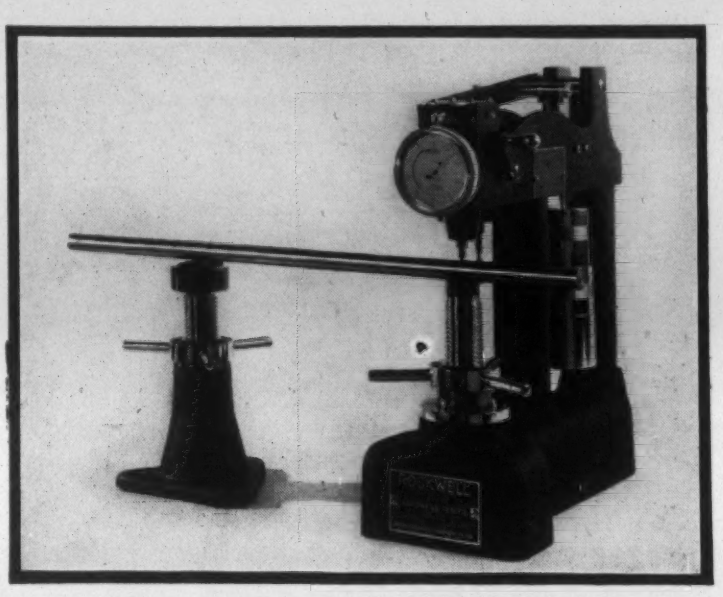

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9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Effect of Size and Shape of Test Specimen Upon the Observed Physical Properties of Structural Steel. Inge Lyse & C. C. Keyser. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, pages 202-210; discussion pages 211-210. This paper presents the results of an investigation of the effect of size and shape of test specimens upon the observed Johnson's elastic limit, the tensile strength, the percentage of elongation in a 2" gage length, and the reduction of area of the fractured section. The specimens were machined from ¼", ½", and 1" thick plates which were rolled from the same heat of structural grade steel. The size and shape of the test specimens varied from ¼" to 1" diameter bars and from ¼" by ¼" to 1" by 4" rectangular sections. The results showed that the size and shape of the test specimen had practically no effect upon the observed Johnson's limit or the tensile strength of the material. The elongation in 2" increased with the size of the test specimen. The reduction of area of the fractured section decreased with increase in the width-thickness ratio of the rectangular sections, but remained nearly constant for circular bars of different diameters. The ratio between Johnson's limit and tensile strength was nearly constant for the different sizes and shapes of test specimens, but showed a marked difference for different thickness of plate as rolled. The thickness of the plate as rolled had a marked effect upon the Johnson limit, but only slight effect upon the tensile strength. Only slight differences in results were obtained on specimens having the full thickness of the rolled plates and on specimens machined from the center portion of the plate. The results of this investigation substantiate those of previous studies which have shown that the observed strength properties are little, if any, affected by the size and shape of the test specimen, while both elongation in 2" and reduction of area are affected appreciably. VVK (9b)

Comparison of Brinell and Scratch Hardness (Vergleich von Brinell- und Ritzhärte). E. Scheil & W. Tonn. *Archiv für das Eisenhüttenwesen*, Vol. 8, Dec. 1934, pages 259-262. In homogeneous metals and alloys there is a definite relation between scratch and Brinell hardness. Through cold working, precipitation hardening, and the formation of a martensitic structure in low C alloys, only the Brinell hardness is raised, and not the scratch hardness. In quenched higher C steels, however, high scratch hardnesses are attained. There is no simple relation between the hardening of martensite and the expansion of its lattice by interstitial C. SE (9b)

Inspection and Testing of Laminated Bearing Springs for Railway Vehicles. H. Roemmelt. *Engineering Progress*, Vol. 15, Nov. 1934, pages 232-234. Static and dynamic testing machines are described for inspecting and determining the characteristics so that springs of equal properties be used in the same car. The apparatus is operated electrically and hydraulically. Ha (9b)

Stress Distribution in Construction Elements. Results of Previous Research Evaluated for Practical Use (Spannungsverteilung in Konstruktions-elementen. Auswertung der bisherigen Forschungsergebnisse für die praktische Anwendung). Ernst Lehr. VDI Verlag, Berlin, 1934. Paper, 8¼ x 11¾ inches, 64 pages. Price 7.50 RM. The Verein deutscher Ingenieure has published in this monograph by E. Lehr a collection of stress distribution data that should prove of real value to the practical man. Here for the first time the information derived by all the methods of stress analysis is assembled, compared and discussed from the standpoint of the engineer. The first half of the book is a critical review of each of the methods of measuring stresses. Each is treated briefly with drawings and photographs of apparatus, explanations of principles, examples of data obtained and discussions of limits of error. In the second section of the book the results of various investigations are brought together, appraised, and presented in usable form by graphs. Throughout the book the explanations are simple and clear, with emphasis given to the rules of safe structural design that may be inferred from the correlated data. In the first section will be found descriptions of a dozen different kinds of strain gages, discussions of methods involving elastic models, brittle models, brittle lacquer, the photoelastic methods, and methods based on analogies with elastic membranes, with electric current flow, and with fluid flow. The second section covers stress distributions in a series of elemental forms frequently encountered in construction (circular and elliptical holes in plates, angles, and eyebars, shafts and beams of changing section, notched shafts and beams, shafts with collars, and shafts with keyways) and distributions in a few examples of more complex parts (elliptical links, gear teeth, hooks, crank shafts, and boiler ends). There is an excellent bibliography of 204 references. One may find a detailed discussion of stress conditions in most of these forms and in several others in English in "A Treatise on Photoelasticity" by Coker and Filon, from which Lehr took many of his graphs of the isoclinics, the principal stress lines, and the stress distributions; the elaborate mathematical analysis of this reference book is omitted by Lehr, who presents only the simpler formulas of ready usefulness to engineers. A feature not found in Coker and Filon's book is the correlation and evaluation of data from several different methods in addition to the photo-elastic method, a strong point in Lehr's book. C. S. Barrett (9b)—8—

Effect of Thickness on the Accuracy of Rockwell Hardness Tests on Thin Sheets. R. L. Kenyon. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, 1934, pages 229-238; discussion pages 239-243. The wide use of the Rockwell hardness test on sheet and strip metals makes it highly desirable to know the limitations within which the results are satisfactorily accurate. This paper deals with thickness only, with two types of surfaces, polished and etched. Low-carbon killed steel sheets free from segregation, annealed and etched to the desired thickness and then polished were used. For the etched specimens, 0.0005" was then etched from each surface. Hardness tests made on polished specimens show, in general, a constant value with decreasing thickness until a certain thickness is reached at which a bulge appears on the under surface and a lower hardness reading is obtained. This gives a series of limiting values for material of varying hardness. It is difficult to detect the first appearance of a bulge on the etched specimens, but the thickness limit in this case can be taken at the point where the Rockwell reading deviates a definite amount, two Rockwell numbers, from the hardness of the material. On iron and steel the ridge around the spherical impression changes to a depression at a certain thickness of the specimen. There are apparently three influences that affect the Rockwell hardness reading on thin sheets; side flow causing lower readings, anvil effect causing higher readings, and crushing effect or "punching through" causing lower readings. The intensity of these effects varies with thickness, and the reading obtained is the net result of all three superimposed on the normal hardness of the material. Decreasing the load (changing the Rockwell scale) makes it possible to obtain reliable readings on thinner pieces. VVK (9b)

Some Factors Affecting Strain Measurements in Tests of Metals. R. L. Templin. *Proceedings American Society for Testing Materials*, Vol. 34, Pt. II, 1934, pages 182-194; discussion pages 195-201. Results of a large number of tests carried out for the purpose of affording a comparison of deformations on various elements of both tension and compression specimens of various forms in both the elastic and plastic ranges. The testing procedure was laid out for the purpose of determining the effects of eccentric and oblique loadings on the specimens; the effects of different types of testing machine jaws on the deformations obtained and the effects of different types of plugs in the case of the hollow round tension specimens. Results indicate that considerable variations in strain and hence stress are to be anticipated in both tension and compression specimens, even under conditions of testing involving the use of careful technique and good apparatus. They also indicated definitely the necessity for uniform and axial loading of specimens, especially when determining the elastic modulus. Under such conditions of testing, it appears relatively unimportant whether strains are measured on one or more elements of the specimen. Under conditions of some non-uniform or non-axial loading more satisfactory modulus values are obtained if strains on opposite elements of a specimen are averaged. The test conditions for obtaining satisfactory yield strength values are much less exacting than those for obtaining satisfactory modulus values. Strain readings obtained on any one element parallel to the axis of a specimen, either in the tension or compression test, will give quite satisfactory yield strength values. The facts presented emphasize the necessity of considering the purpose of the test results in selecting suitable methods of testing. VVK (9b)

Round Tensile Bars for Cast Iron. A. C. Vivian. *Foundry Trade Journal*, Vol. 51, Aug. 16, 1934, pages 100-101, 112. The influence of alterations in the relative dimensions of turned bars for tensile tests on cast iron is illustrated with the aid of sheet-rubber models. The author comes to conclusion that for any grade of cast iron devoid of appreciable plasticity, the shape of a turned bar should have the relative dimensions which are given by him. He states that with any geometrically similar bar of the proportions shown in the paper, it should be possible to obtain the true tensile strength and tensile stress-strain relation (on a 1" gage length). For ¼ in.² cross section the diam. of the breaking section is 0.564", its length 2", fillets 2.4" radius, length 1", leading into a cylindrical section 0.5" long, 1" diam. beyond which is a grip 2" long, ½" diam. The overall length is 9". For cross sections of ½, 1 and 1/50 in.² all dimensions are increased or decreased proportionately. AIK (9b)

Concerning the Effect of Notches and Laws of Similitude in Material Testing. A. NADAI & C. W. MACGREGOR. *Proceedings American Society for Testing Materials,* Vol. 34, Pt. II, 1934, pages 216-228. In a number of recent investigations on the various effects of stress concentration produced by notches, size effects and other discrepancies have been observed. Some of these cases are briefly analyzed and an attempt is made to include in the comparison factors such as the speed of deformation, geometrical and mechanical similitude. The effect of the speed of deformation for ductile metals and finally the strength of notched bars of ductile metals is discussed and some tests with notched steel and aluminum bars reported. These latter did not indicate a size effect such as has been suspected by other investigators. VVK (9b)

Tension Testing of Metals—New Standard Methods. R. L. TEMPLIN. *Metal Progress,* Vol. 27, Feb. 1935, pages 29-32. Describes the new standard tensile test methods of A.S.T.M. giving diagrams of specimens with tabulation of various dimensions permissible with different sizes. Defines a yield strength as that at which a 0.2% set is exhibited and points to the need for such definition for materials which do not exhibit the "kneed" stress-strain curve. Graphs show the effect of magnification in the extensometer upon the accuracy of determination of any fixed value of set. Methods of calibration and specification of accuracy of extensometers are the next step in standardization of tensile tests. WLC (9b)

Researches in Impact Testing. H. HALLAM & R. V. SOUTHWELL. *Engineering,* Vol. 138, Dec. 21, 1934, pages 689-690; Dec. 28, 1934, pages 703-704. From a paper read before Section G of the British Association for the Advancement of Science, Aberdeen, Sept. 1934. LFM (9b)

A Recording Extensometer (Ein schreibender Dehnungsmesser). F. DE LA C. CHARD. *Elektrotechnische Zeitschrift,* Vol. 55, Dec. 27, 1934, pages 1276-1277. An electric instrument is described which consists of a small double condenser two of the layers of which are connected to a small shaft which follows the variations in length. The currents due to the change in capacity of the condensers are amplified and operate recorder or oscillograph. Ha (9b)

The Meaning of the Transverse Test of Cast Iron to the Designing Engineer. JAMES T. MACKENZIE. *Foundry Trade Journal,* Vol. 51, Aug. 30, 1934, pages 129-132. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 530. AIK (9b)

Wear Testing Machine. *Engineer,* Vol. 158, Dec. 7, 1934, pages 565-566. Illustrated article describing the Skoda-Sawin machine which tests wear by means of a standard rotating disc of Widia. It tests the surface in less than 5 min. and expresses the resistance against wear in units of volume of the impression in thousandths of a cubic millimeter. The surface tested is not changed. LFM (9b)

5-Ton Self-Indicating Testing Machine. *Engineering,* Vol. 138, Nov. 2, 1934, page 479. Illustrated article describing new machine introduced by Messrs. W. and T. Avery, Limited of Birmingham. Tensile, compression, transverse, shear and hardness tests can be carried out on the machine which is of the hydraulic type. LFM (9b)

Photoelastic Study Facilitates Designing Large Casting. *Iron Age,* Vol. 134, Oct. 18, 1934, page 35. Brief account of the procedure by engineers of Baldwin-Southwark Corpn., Philadelphia, in designing yoke for use in connection with a large and heavy bending roll. The shape of the part and manner of loading made analytical investigation difficult. Therefore scale model was made in steel plate. Satisfactory results were obtained. VSP (9b)

Torque-testing Fixture. *Machinery,* London, Vol. 44, Sept. 13, 1934, page 703. A machine for determining and limiting torque on screws and studs in assembling in order to prevent stripping. WB (9b)

9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cöoperation with the A.S.T.M. Research Committee on Fatigue of Metals.

The Degree of Fatigue and Recovery therefrom of Carbon Steels under Repeated Impacts. FUMIO OSHIBA. *Kinzoku no Kenkyu,* Vol. 11, July 1934, pages 328-343. In Japanese. Fatigue phenomenon under repeated impacts and the recovery by a heat treatment were studied on 0.2, 0.3, 0.4 and 0.7% Swedish C steels. The degree of fatigue was calculated by the following formula $F = \frac{W_o - W}{W_o}$, where F denotoes the degree of fatigue, W_o and W the impact figure of the specimens before and after they underwent repeated impacts. The degree of fatigue progresses as the number of blows increases at 3 different rates; in the first stage of impacts, it progresses slowly and in the second stage very rapidly, while in the last again slowly until a specimen breaks down. The duration of all stages is long and distinct when the impact-stress is small. The first stage is long when round specimens were used and small stress was applied, while the third stage is very long when rectangular specimens were used. The higher the C content in steels, the greater the degree of fatigue in the earlier stage and the smaller in the later stage of impacts. Some recovery from fatigue by an annealing takes place throughout the various stages of impacts, but the recovery (which is measured by increase in Charpy value) which occurs in the stage between the second and third stages is most conspicuous. Some recovery can occur after visible cracks form but it is not so conspicuous. It was also found that the progress of the degree of fatigue was closely related to the development of the fatigue cracks, which appear first at the end of the first stage of impact. KT (9c)

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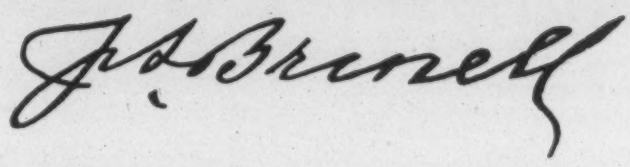

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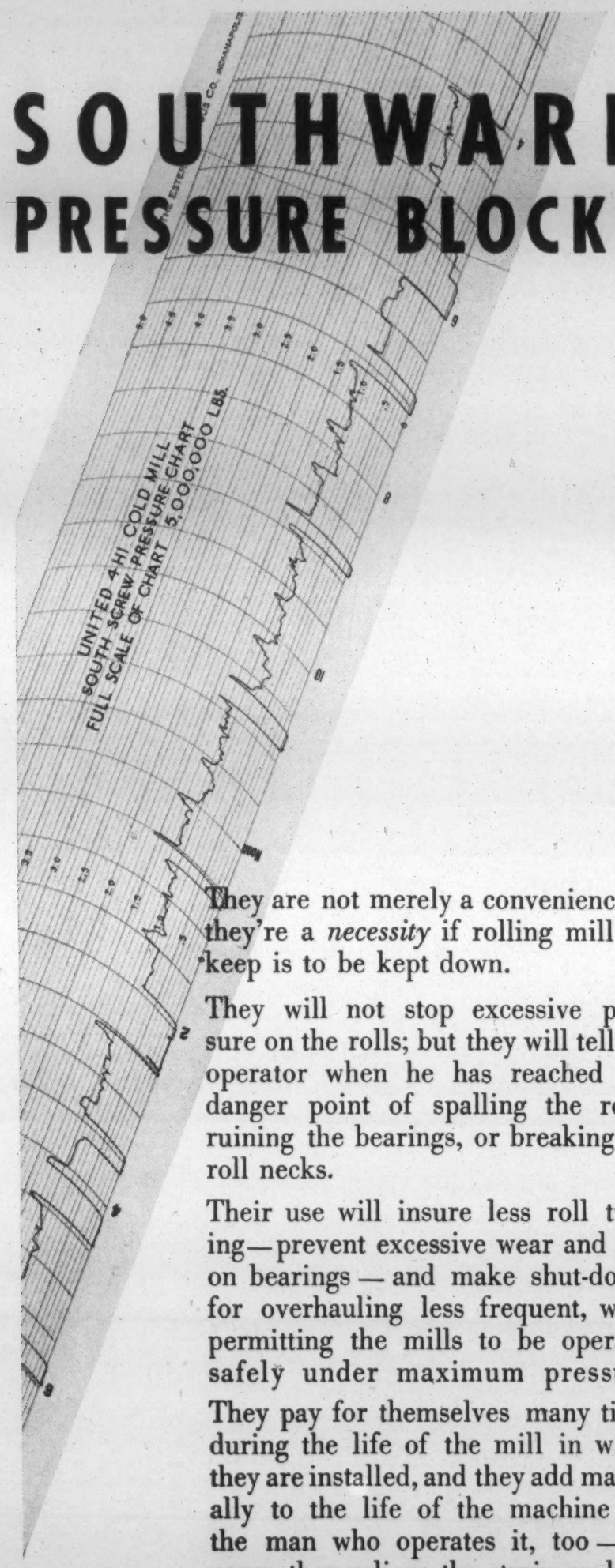

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Some Aspects of the Fatigue Properties of Patented Steel Wire. E. T. Gill & R. Goodacre. *Engineering*, Vol. 138, Dec. 21, 1934, pages 692-694. From a paper read before the Iron & Steel Institute, Brussels, Sept. 10, 1934. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 577. LFM (9c)

Effects of the Greatest Possible-Previous Stresses on the Tensile Stress of Rail Steel (Versuche zur Ermittlung der Wirkungen grösstmöglicher Vorspannungen bei der Zugbeanspruchung des Schienenstahls). E. Cotel. *M. Kir. Joszef Nador Müszaki es Gazdasagtudomanyi Egyetem Banya-, Koho- es Erdömernöki Kar Sopron (Royal Hungarian Palatin-Joseph University of Technical and Economical Sciences, Faculty of Mining, Metallurgy and Forestry, Sopron)*, Vol. 6, Dec. 1934, pages 19-23. The experiments had the object of finding a reason for the endurance fractures in rails which sometimes occur in service after a number of years without apparent reason. Tests with new rails were made whereby one part of the specimens was subject to rapid tensile tests to obtain the normal value while others were stressed at first up to different stresses and then released. It was conclusively shown that for previous stresses up to 50% of the tensile strength no permanent deformations occurred. Permanent deformations (expansions) take place between 50 and 90% of the tensile strength without however involving any danger for the safety (due to reduction of tenacity) of the rail. But if previous stresses reached or exceeded 90% the rail will be liable to sudden fracture. Such previous stresses may in practice occur in the rail due to the continuous expansion or shrinking because of temperature changes but this danger is very remote, and endurance fractures can be in fact rather traced to minute defects in the rail, as slag inclusions, segregations, etc., as has been pointed out by Oberhoffer and Graff. Ha (9c)

Corrosion Fatigue Study of Welded 18-8 Stainless Steel. Wilber E. Harvey, Arthur J. Ciastkewicz & F. Jerome Whitney. *American Welding Society Journal*, Vol. 14, Jan. 1935, pages 18-23. R. R. Moore rotating beam fatigue machine used with city water as corroding medium. Welded specimens of Rezistal KA-2, 18-8 tested, both gas and resistance welds. High corrosion fatigue for resistance weld material, very low limit for gas weld. Gas weld is anodic to parent metal, resistance weld is cathodic to parent metal. Heat treatment to dissolve carbides increases resistance to corrosion fatigue. WB (9c)

The Endurance Limit of Light Metal Castings (Die Wechselfestigkeit von Leichtmetallguss). W. Linicus & E. Scheuer. *Metallwirtschaft*, Vol. 13, Nov. 23, 1934, pages 829-836; Nov. 30, 1934, pages 849-855. The effect of various factors on the endurance limit of Al and Mg alloys, especially Silumin, was investigated, and the results obtained by other workers are given for comparison. The endurance properties of sand cast light metals were affected hardly at all by the casting skin, tool marks or notches. In chill castings the endurance limit was lowered 10 to 20% by surface irregularities. As other metals, the light alloys are affected less in the cast than in the rolled state. The effect of corrosion by tap water and 3% NaCl + .1% H_2O_2 solution for 10 days, 50 million reversals, was comparatively slight on the endurance properties of Al alloys with no or very little Cu, much smaller than on cast iron and Mg alloys. Changes in the rate of solidification had no effect on the endurance properties of eutectic Silumin, but had considerable effect on the endurance, as well as other mechanical properties of other cast alloys, especially due to internal shrinkage on too rapid cooling. Grain size in itself had little influence, but the rate of solidification was found to determine the concentration of solid solution, and this affects the endurance properties. While others have determined that the endurance properties of heat treatable Al alloys are increased up to 20% by heat treatment, less than the static mechanical properties, it was found that the endurance limit of Silumin γ could be raised 40%. The endurance limit and tensile strength did not change in the same proportions. In ordinary Silumin the endurance limit could also be raised by quenching, without similar change in static properties. A tabulation is included of all published results of endurance tests on cast light metals. The alloys Y, RR 53, and Silumin gamma show the highest endurance limit. In the chill cast state they approach heat treated rolled Al alloys. The difference between Silumin test bars and sections cut from larger castings was also investigated. The endurance limit of the castings was not more than 10 to 20% below that of the test bars. In non-eutectic alloys the difference is probably greater. 32 references. CEM (9c)

Alternating Stressing of Tubes Subjected to Internal Pressure (Wechselbeanspruchung von Rohren unter Innendruck). A. F. Maier. *Stahl und Eisen*, Vol. 54, Dec. 13, 1934, pages 1289-1291. Endurance tests in tension of low carbon steel and cast-iron tubes subjected at the same time to internal pressure, showed no rise in the endurance limit called for by the structure change—energy hypothesis. SE (9c)

Notch Sensitivity on Repeated Stressing of Carbon and Alloy Steel (Kerbempfindlichkeit bei Wechselbeanspruchung von legierten und unlegierten Stählen). R. Mailänder. *Stahl und Eisen*, Vol. 55, Jan. 10, 1935, pages 39-41. 380 repeated bend fatigue tests indicated that the notch sensitivity depends on the tensile strength, the notch sensitivity being defined as $\frac{\sigma_w - \sigma_{wk}}{\sigma_w}$ where σ_w is the endurance limit of a polished sample and σ_{wk} is the endurance limit of a sample with a sharp notch. The alloy steels were grouped as follows:—Mn and Si; Ni; Cr; Cr-Ni; and austenitic steels. When steels with the same endurance limit in as-polished samples were compared, the carbon steels showed a somewhat higher notch sensitivity than the alloy steels, this being attributable to the higher tensile strength of such C steels. The results showed considerable scatter so that in more than one instance a C steel showed lower notch sensitivity than an alloy steel. The most significant fact, however, was that for the same tensile strength the alloy steels generally showed higher endurance limits, both in polished and in notched samples, than the C steels. SE (9c)

On the Repeated Torsion Tests of Steel. Tosio Nisihara & Yosiyasu Kawakura. *Society of Mechanical Engineers Japan*, Vol. 37, Sept. 1934, pages 593-598. In Japanese. Paper read before the Special Meeting of the Society of Mechanical Engineers at Kobe, Nov. 3, 1933. Description of testing machine used for endurance tests to determine the effect of keyways on the fatigue limit of round bars made from ordinary C steels. The rise in temperature of the test piece at the endurance limit did not vary according to the material used but depended only on the form of the specimen. Kz (9c)

9d. Magnetic Testing

L. REID, SECTION EDITOR

The Quality of Steel and Magnetic Research. T. F. WALL. *Engineer*, Vol. 158, Dec. 7, 1934, pages 564-565. From *Quality*, Journal of the Sheffield Chamber of Commerce. Brief summary of some of the magnetic methods being developed in the Electrical Engineering Department of Sheffield University.
LFM (9d)

9e. Spectrography

Metallurgical Spectrum Analysis with Visual Atlas (Separate Portfolio). WELTON JOSEPH CROOK. Stanford University Press, Stanford University, 1935. Cloth, 8¼ x 11¼ inches, 82 pages. 24 plates 11" x 14" in portfolio. Price $12.50. The author, Professor of Metallurgy at Stanford University, limits himself to the application of the spectrograph as a tool useful in metallurgical analysis, especially of steels. A rather complete treatment of a single apparatus and method of use is given. Many will not agree that the method chosen has the superiority in cost and simplicity which is claimed for it. However, for the study of ferrous materials, a powerful method is necessary and confusion is avoided by confining the discussion to one adequate method. The equipment consists of a 21 foot reflection grating in a modified Rowland mounting. The light source is a Pfund arc between Armco iron or carbon electrodes, the sample being introduced into a cavity as drillings. The necessity of providing a large vibration-free room and of designing and constructing the entire apparatus (with the exception of the grating which requires both love and money to secure) will seriously restrict the use of this equipment in industry. Spectograms are taken in the first order of the grating. Two settings are used, one giving the region from 2800 to 3400 A. in the ultra-violet and the other from 5000 to 5600 A. in the visible. The negative is placed in an enlarger and projected at such a magnification that the iron lines coincide with the iron lines of the proper plate of the visual atlas provided. Lines corresponding to any of 31 metallic elements can now be identified immediately. If wave lengths are desired, they can be directly estimated to better than 0.1 A. In addition to the visual atlas plates, tables of arc spectrum lines in order of wave length are given for numerous elements. The atlas and tables cover only arc lines in the regions from 2800 to 3400 A. and from 5000 to 5600° A., which the author asserts will serve for the identification of the elements likely to be met in metallurgical work. A brief treatment of quantitative spectrum analysis is given wherein National Bureau of Standards analysed steels are used as standards. The author takes the very sound position that, at present, the spectrograph cannot supplant chemical analysis, but that it can be a useful adjunct to chemical methods. The book, and especially the tables and atlas, will be welcomed by those actively engaged in spectrographic analysis or contemplating such work.
H. W. Russell (9e)—B—

The Spectrographic Analysis of Some Alloys of Aluminum. ERNEST H. S. VAN SOMEREN. *Journal Institute Metals*, Vol. 55, Advance Copy No. 681, Sept. 1934, 8 pages. Technique is described for analyzing Al alloys by means of their spark spectra in the ultra violet, using the method of internal standards. Tables are given for estimation of Cu, Zn, Fe, Si, Mn, Mg, Ni, Sn, and Cd, and for the detection of Pb, Sb, Cr, Ti, and Bi. For the detection of Sn, Pb, Bi, and Sb the arc method is at least 10 times more sensitive than the spark. JLG (9e)

Quantitative Spectro-Analysis of Metals Present in Small Quantities in Light Metal Alloys. Novel Method of Analysis; Determination of Magnesium in Aluminum and Duralumin (Analyse spectrale quantitative des métaux en faible proportion dans les alliages légers: nouvelle méthode de dosage, détermination du magnésium dans l'aluminium et le duralumin). HENRI TRICHÉ. *Bulletins de la société chimique de France*, Vol. 5, Apr. 1934, pages 495-505. Concerning quantitative determination of Mg in Al, chemical methods were found to be superior down to Mg : Al = 2 : 1000. Below this concentration spectroscopic analysis is more accurate. The relative sensitiveness is constant and amounts to 10% except in the case of exceedingly low amounts of Mg in Al. Then the accuracy of spectroscopic analysis drops to 20%. With respect to analysis time, spectrographic methods stand out particularly if several alloys are tested simultaneously. Spectroscopic analysis does not require any separation. The intensities were found to depend not only on the concentration of both metals to be compared but also on other impurities. This effect is less pronounced at very low concentrations.
EF (9e)

The Rapid Spectroscopic Determination of Alloying Elements in Special Steels (Zur spektroskopischen Schnellbestimmung von Legierungsbestandteilen in Sonderstählen). O. SCHLIESSMANN. *Archiv für das Eisenhüttenwesen*, Vol. 8, Oct. 1934, pages 159-164. It is shown how Al, Co, W, Nb, Cr, V, Mo, Ti, Ni, Mn, Cu, and Li can be qualitatively and quantitatively determined in alloy steel very rapidly in a 2 prism spectroscope by the arc spectra. The spectral lines that can be used for these determinations are illustrated and given in tables.
SE (9e)

Spectrum-Analytical Investigations of Impurities in Materials (Gegenwärtiger Stand der spektralanalytischen Untersuchung von Beimengungen in Werkstoffen). H. MORITZ. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Dec. 15, 1934, pages 1453-1456. The method of chemical emission spectrum analysis is discussed with regard to application in routine examinations and equipment and apparatus for it reviewed and described. Qualitative and quantitative determinations are now made.
Ha (9e)

A High Vacuum X-Ray Spectrometer for Concave Crystals of the Johann Type (Ein Röntgenspektrometer für Hochvakuum mit Konkavkristall nach Johann). ARNE SANDSTRÖM. *Zeitschrift für Physik*, Vol. 92, Dec. 7, 1934, pages 622-630. The use of a crystal with a concave surface eliminates the former difficulty of poor focusing on the photographic plate which occurs when the crystal has a plane surface and the X-rays strike against the plate at an angle. The intensity distribution of the spectral lines is greatly improved.
FHC (9e)

10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Magnetic Investigation of Precipitation Hardening (Magnetische Untersuchung der Ausscheidungshärtung). HERMANN AUER & WALTHER GERLACH. *Metallwirtschaft*, Vol. 13, Dec. 7, 1934, pages 871-873. A method for determining changes in magnetic susceptibility in metals was developed which is accurate to 1%. The tests were made on an alloy of pure Al plus 5% Cu in the form of 3 mm. diam. rods, and the results were corrected for Fe content. The samples were heated at 525°C. for 1 hour, quenched in ice water, and immediately tested. They were then heated various lengths of time at 100° to 488°C., quenched and again tested, also after room temperature aging up to 500 hours. The time vs. magnetic-volume-susceptibility curves show that in low temperature aging the susceptibility increases sharply during the first 20 hours, then increases more slowly. At room temperature the rise is not complete after 500 hours. Both parts of the curves become steeper in aging at higher temperatures. From 200° on up the susceptibility becomes constant after 40 to 60 hours. The highest susceptibility is obtained at 200°. At higher temperatures the susceptibility is lower and practically constant from the start of heating. Logarithmic curves clearly illustrate the 2 distinct parts. From 200° on up the susceptibility change with temperature is completely reversible, any point can be obtained by either heating or cooling to the necessary temperature and quenching. Below 200°, any degree of susceptibility can be obtained only by heating to the correct temperature and quenching. The results indicate that the process of precipitation hardening consists of at least two parts.
CEM (10)

Atlas Metallographicus. H. HANEMANN & A. SCHRADER. Gebrüder Bornträger, Berlin, 1933. Sections 6 and 7. 14 sections of this remarkable collection of macro and micrographs have already appeared, but in reviewing them for *Metals & Alloys*, the present sections 6 and 7 were omitted by an oversight. Metallographers who may perhaps regard the Atlas merely as an album will be surprised at the wealth of new experimental material contained. Every figure indeed will repay careful study. Thus section 6, after illustrating various types of dendritic and banded structures as affected by the conditions of solidification and by heat treatment, gives the results of a very pretty series of grain size experiments on low and medium carbon steel, showing the effect of varying the rate of heating and cooling through the critical range. The faster rates gave a finer grain size on both heating and cooling. The "inheritance" effect of original grain size is also brought out. In section 7 it is shown that hot working above the critical temperature produces a finer grain size than is obtained by simply heating to the finishing temperature of the hot working. The section ends with a series of micrographs showing the structures obtained in different carbon steels under rates of cooling corresponding to annealing and to normalizing.
S. Epstein (10)—B—

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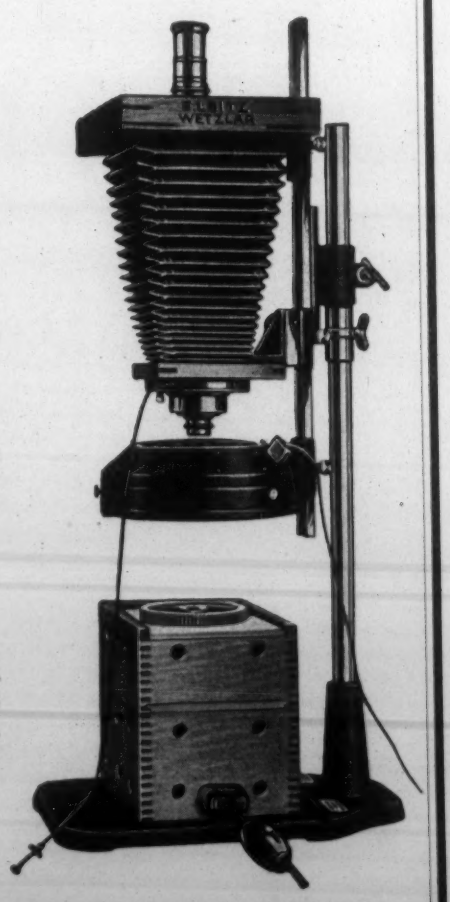


The Lineage Structure of Crystals. M. J. Buerger. *Zeitschrift für Kristallographie*, Vol. 89, Sonderheft "Ideal- & Realkristall," Oct. 1934, pages 195-220. In English. In general, crystals are internally partitioned by discontinuities in such a way that the entire structure is continuous but branched, as is shown by Zn single crystals grown by the Bridgman method. Etching and other means exhibit essentially filled-in dendritic frameworks. This lineage structure is not peculiar to dendritic crystals. A complete gradational series can be traced from dendrites through "parallel intergrowth," through crystals with multiple terminations, through crystals with so-called "mosaic imperfections," to apparently perfect crystals. This lineage structure offers a basis for understanding the so-called "mosaic structure" as well as the sheet structure of Zn and Cd crystals (Straumanis). Additional observations are given on the lineaged nature of spectroscopically pure Zn crystals. Straumanis Zn-Cd sheet intergrowths are also manifestations of this feature. The lack of perfectly parallel orientation in lineages accounts for Darwin's "imperfect crystal" and the observed decrease in X-ray extinctions (Barret & Howe, Leonhardt. Extinction does not depend entirely on crystal species but partly on growth conditions. Interlineage discontinuities are the loci of voids which give rise to the deficient values of experimental densities. Goetz' alleged evidence for "block phase" probably really has its origin in incompletely melted lineage cores. The hardening universally attending plastic deformation must result at least partly from forcing the gliding planes of a lineage over the corresponding plane of its neighbors with which it does not register and with which it is not even parallel. Interlineage solvents and high temperatures reduce the interlineage resistanace to gliding due to local recrystallization action. Variable interlineage resistance allows gliding to occur locally and gives rise to visible slip striae. EF (10)

Diffusion of Elements in the Solid State—A New Aspect (La Diffusion des Éléments à l'État Solide, un Nouvel Aspect). Binayendra Nath Sen. *Comptes Rendus*, Vol. 199, Nov. 26, 1934, pages 1189-1190. When 2 elements are in contact in the solid state, the element that penetrates the other is the one whose atoms are closest together.

Metals	Minimum interatomic distance, cm.x10^{-8}	Direction of Diffusion
Cu-Pt	Cu 2.54 Pt 2.78	Cu penetrates Pt
Cu-Zn	Cu 2.54 Zn {2.67 {2.92	Cu penetrates Zn
Fe-Ag	Fe 2.54 Ag 2.876	Fe penetrates Ag
Au-Pb	Au 2.88 Pb 3.48	Au penetrates Pb
Fe-C	C 1.50 Fe 2.54	C penetrates Fe

(Ed. note:—More to the point would be relative atomic size.) FHC (10)

Mobility of Gold in Solid Lead (über die Beweglichkeit von Gold in festem Blei). W. Seith & H. Etzold. *Zeitschrift für Elektrochemie*, Vol. 40, Dec. 1934, pages 829-832. Solubility of Au in Pb and diffusion velocity of Au were measured from 113°-300°C. The passage of a large current through a rod of Au-Pb produced a concentration of Au at the positive end. Pressures of 800-1000 atmospheres had no effect on diffusion of Au. WB (10)

Investigations of Equilibria of Alloyed Bronzes. The Copper-rich Copper-manganese-tin Alloys (Untersuchungen über Gleichgewichtsverhältnisse weiterlegierter Bronzen. Die kupfer-reichen Kupfer-Mangan-Zinn Legierungen). J. Verö. *Mitteilungen der berg- & hüttenmännischen Abteilung der königlich-ungarischen Hochschule für Berg- & Forstwesen, Sopron*, Vol. 5, 1934, pages 128-155. In German. Englist summary. The Cu-rich corner of the ternary Cu-Mn-Sn diagram was investigated microscopically and by thermal analysis up to 15% Mn and to the quasi-binary section Cu_3Sn-Mn with the following results: Sn has a more pronounced affinity for Cu than for Mn. Solidification and transformation temperatures of the binary Sn bronzes are lowered by additions of Mn. Less Sn is dissolved by the α-solid solution with rising Mn contents. The various phases and reactions of the binary system are present up to 4% Mn, which amount is dissolved by all of the bronze constituents. From 5% Mn up, the β phase and the transformation connected with this phase are absent. A new Mn-rich phase, designated as x, appears at about 4% Mn. The x crystals precipitate from the γ- solid solution and change radically the microscopic appearance of the $\alpha + \delta$ eutectoid. Concerning the horizontal at 580°C. in the $\alpha + \beta$ homogeneity range of the binary Cu-Sn system, it is concluded that only the conception of Hoyt, Bauer & Vollenbruck holds. WH (10)

Expansion in Tempering Hardened 1.15% Carbon Steel (Dilatationsmätningar vid anlöpning av härdat stål med kolhalt 1.15%). Torkel Berglund. *Jernkontorets Annaler*, Vol. 114, Oct. 1934, pages 495-514. Measurements were made on the change in length of mildly heated carbon steel, containing 1.15% C, 0.30% Mn and 0.20% Si, using the interference method of the U. S. Bureau of Standards. The length increases steadily to 770°, when a slight contraction is noted due to solution of about 0.80% C in the γ phase, after which the length again shows a steady increase up to 900°. On cooling, the length decreases regularly (without showing a break at 770°) to 200°C., when martensite begins to form, accompanied by dilation. At room temperature, the length is 31.2 μ per cm. greater than on the original heating; subsequent heating shows irregular expansion. Hardened samples were tested at constant temperatures for time intervals of 5 to 1000 minutes; the following conclusions were obtained: (1) from room temperature to 100°, the contraction increases with time, (2) from 115 to 180° the contraction decreases, (3) from 200 to 250°, it increases, and (4) from 300 to 450° it decreases until at 500° there is a slight expansion. No relation was found between Rockwell hardness and change in length. The contraction curves indicate that the atom groupings change in two steps during annealing but the nature of these changes is not clear. HCD (10)

Apparatus and Method for Metallographic Work at Low Temperatures. Q. A. Knight. *Metals & Alloys*, Vol. 5, Nov. 1934, pages 256-258. Descriptive. WLC (10)

A Two-crystal Moving-film Spectrometer for Comparative Intensity Measurements in X-Ray Crystal Analysis. J. Montieth Robertson. *London, Edinburgh, & Dublin Philosophical Magazine & Journal of Science*, Vol. 18, Nov. 1934, pages 729-745. An instrument for general use in X-ray crystal analysis is described which is useful for recording accurately whole zones of reflections from each crystal (one of which may be a standard) so that accurate comparisons can be made. The operation of the instrument is described and a table of film correction factors for interpretation of the films is given. IIa (10)

Growing Magnesium Crystals (Wachsende Magnesiumkristalle). M. Straumanis. *Zeitschrift für Kristallographie*, Vol. 89, Nov. 1934, pages 487-493. Pursuing previous research work, (See *Metals & Alloys*, Vol. 3, May 1932, page MA 126; Vol. 5, Feb. 1934, page MA 45, L-7; Vol. 5, Dec. 1934, page MA 581, L-7). Mg crystals grown from the gaseous state were found (1) to be faced by 0001, 1010 and 1011 and (2) to possess only part of these faces and otherwise a curved surface. Nevertheless the internal structure was shown to be of regular arrangement. Microscopic investigation proved that in the initial state, crystal nuclei can grow, particularly with higher oversaturations without specific faces. As the nucleus grows, the velocity of growth drops and the faces of the equilibrium state appeear after an intermediary state characterized by the adjacent surfaces. The latter occur only on rapidly growing crystals and are filled-in as the growing conditions approach equilibrium. These instability phenomena observed on Mg could not be observed with growing crystals of Zn and Cd. EF (10)

Some Conclusions from Rules on the Concentration of Valency Electrons in Binary Intermetallic Alloys. H. Perlitz. *Journal of Chemical Physics*, Vol. 1, May 1934, pages 335-336. β, γ, and ϵ structures are not to be expected in binary intermetallic alloys if both components have the same number of valency electrons. A β, γ, or ϵ structure is to be expected in binary intermetallic alloys if the one component has less and the other component more than 3 : 2, 21 : 13 or 7 : 4 valency electrons respectively. Since the characteristic values of concentrations of valency electrons are between 2 consecutive integers, it follows that in alloys in which one of these structures referred to is present, both other structures should be expected too. This statement accounts for the frequent coexistence of β, γ, and ϵ structures. Since the lower and upper limit for the values of concentration of valency electrons are 0 and 2, it follows that α, β, γ, and ϵ structure is to be expected in binary alloys if the one component has less than 1 valency electron and the other has more than 2 valency electrons. EF (10)

Anisotropy of the Speed of Growth of New Crystals During Recrystallization (Anisotropie der Wachstumsgeschwindigkeit neuer Körner bei der Rekristallisation). M. Kornfeld. *Physikalische Zeitschrift der Sowjetunion*, Vol. 6, No. 1/2, 1934, pages 170-174. Hard-drawn Al wire of 99.5% purity was annealed at 400° C. for 2 hours and Laue diagrams were taken. These exhibited the typical recrystallization texture. Then the samples were deformed (3% elongation) and annealed between 400° and 440° C. and the newly formed crystals studied. Whereas the characteristic recrystallization structure was noticed at higher temperatures, an anisotropic growth of the new crystals was established at the lower limit of the recrystallization-temperature range. The new needle-shaped crystals could be detected in X-ray pictures alongside the parent polycrystals. This phenomenon of preferred growth in the direction of the fiber axis of the wire may be due to the fact that (1) the separation energy ("Abtrennungsarbeit") of the atoms from the crystallographic planes perpendicular to the wire axis is smaller than in other planes and (2) the hindrances to the passage of the atoms of the crystals reducing in size to the growing ones are primarly arranged along the wire axis. EF (10)

Mechanism of the Eutectic Crystallization (Über den Mechanismus der eutektischen Kristallisation). A. A. Botschwar. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 220, Nov. 17, 1934, pages 334-336. Of some interest to the theoretical metallurgist because of the use of 2 organic substances (piperonal and azobenzole) that could be distinguished by color and that form a eutectic around 26° C. Microscope study was made of crystallization of the mixture as a function of undercooling and crystallization velocity. WB (10)

Polishing Cast Iron Specimens. Eugene W. Nelson. *Foundry*, Vol. 62, Feb. 1934, pages 12-14, 54. From a paper presented before the 1933 short foundry course at Michigan State College. Pays special attention to the dragging out of graphite flakes during polishing. Many so-called "graphite flakes" in specimens polished on broadcloth are really cavities from which graphite has been removed. Describes a new method of polishing on napless velvet pad impregnated with rouge, which reduces polishing difficulties and gives a perfect polish. Photomicrographs showing effect of poor polishing are included. VSP (10)

Iron, Cast Iron and Steel (Fer, Fontes, Acier). Try-Chalons. *Revue de Fonderie Moderne*, Vol. 28, Nov. 10, 1934, pages 314-315. A new definition is derived from modern metallographic knowledge which permits distinction of these 3 often confused terms. Eutectiferous products are called cast iron. Steel is a non-eutectiferous carburized product which shows eutectoid transformation; this group is subdivided into hypoeutectoid and hypereutectoid steels. Iron does not undergo eutectoid transformation. The demarcation between the 3 states is shown in the constitutional diagram. IIa (10)

Solubility of Copper in Iron, and Lattice Changes during Aging. John T. Norton. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 586, Dec. 1934, 9 pages. Alloys containing as much as 3.4% Cu were prepared by melting very pure Fe and Cu in a vacuum. The solid solubility of Cu in Fe was determined by the conventional X-ray method. It was found to be 1.4% at the eutectoid temperature and 0.35% at 650° C. and below. This agrees with precipitation-hardening data but not with the results of other determinations. Heating curves showed the eutectoid temperature to be between 855 and 860° C. According to X-ray studies of precipitation-hardened material, maximum hardness resulted when a fourth or a fifth of the available Cu had precipitated. Complete precipitation is accompanied by a decrease in hardness. It is suggested that precipitation hardening is due to 2 factors: (1) the pre-precipitation rearrangement of the solid solution, which is the principal cause, and (2) the actual precipitation. The relative magnitude of these 2 factors is not dependent on the aging temperature. 6 references. JLG (10)

11. PROPERTIES OF METALS AND ALLOYS

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Working in Precious Metals. E. A. SMITH. N. A. G. Press, Ltd., London, 1934. Cloth, 6 x 9 inches, 400 pages. Price $2.50.

This book is the best combination of information from tradition and art with the science of physical metallurgy as applied to the precious metals that has come to the reviewer's attention. The style is clear and attractive. In certain sections there is unnecessary detail for the trained metallurgist, but the author also had in mind the practical worker (craftsman) who may need just those details in order to understand and use this new publication. Chaps. I, the Scope of Metallurgy; II, Craftsmanship and Science; III, Modern Views of Metals and Alloys; and IV, Methods of Investigation, are introductory and are covered in 16 pages.

Chaps. V, Crystalline Structure of Metals; VI, Constitution and Structure of Alloys; and VII, Cooling Curves and Equilibrium Diagrams, pages 17-45, present a brief elementary treatise of the terms and principles of physical metallurgy. Starting with Chap. VIII, attention is directed to the precious metals, but the non-precious alloying metals are also considered. Chap. VIII, Materials, Fluxes, and Melting Appliances, begins to show the author's ability to present a combination of the craftsman's and metallurgist's knowledge. The modern character of this chapter is indicated by discussion of the use of high-frequency induction furnaces in melting precious metals and alloys, pages 46-77. Chap. IX, Melting and Casting, pages 78-100, discusses both gold and silver alloys as cast into ingots and special shapes. Certain alloys should cool slowly in the molds, while others, relatively high in Cu/Au ratio, should be quenched for good rolling properties.

Chap. X, Mechanical Treatment, pages 101-175, is one of the most valuable and contains information which should be of interest in other fields than precious metals. Special attention is given to possible damage to the metal by rolling, drawing, hammering, and swaging. Chap. XI, Annealing, pages 176-201, features recent developments in annealing, such as controlled atmosphere and salt baths. Annealing time and temperatures and the effects on the physical properties and microstructures are discussed. Chap. XII, Chemical Treatment, pages 202 to 217, is devoted to cleaning of metal surfaces and producing certain desired colors on finished products.

Chap. XIII, Gold and Its Industrial Alloys, pages 218-278, will be of special interest to those who are seeking information about the compositions or formulas which are being used for various purposes and the properties of these alloys. Gold and its alloys are grouped according to gold content or fineness, pure gold, 22, 20, 18, 16, 14, 12, 10, and 9 carat alloys. The white golds are given some attention (13 pages).

Chap. XIV, Silver and Its Industrial Alloys, pages 279-293, seems rather brief, although it discusses silver and silver-copper, silver-zinc and silver-cadmium alloys, sterling silver, and recent work on the production of tarnish-resisting silver alloys.

Chap. XV, pages 294-307, relates to the platinum-group metals and their alloys. The treatment is interesting and valuable but quite incomplete.

Chap. XVI, Solders and Soldering, pages 308-341, contains valuable information on gold, white gold, silver, and platinum solders, and on soldering techniques. Chaps. XVII, XVIII, XIX, pages 342-370, are brief and relate to Polishing and Finishing, Precious Metal Enameling, and Collection and Treatment of Waste, respectively. Chap. XX, pages 371-391, gives a brief discussion of precious metal substitutes.

One may be disappointed that the author has given practically no attention to precious metals in dentistry, a field in which there has been considerable research in this country during the past two decades and in which the use of palladium, according to annual reports, is frequently greater than in any other industry. It is also disappointing that several important American publications are not included in the references.

The physical metallurgist will find this book interesting reading and will have a chance to become acquainted with some of the vocabulary of the craftsman.

Oscar E. Harder (11a)—B—

Properties and Uses of Lithium (Propriétés et Usages de Lithium). J. STAES. *Revue Universelle des Mines*, Vol. 10, Dec. 1, 1934, pages 635-637. Li, the lightest solid substance known, (sp. gr. 0.53) and with a melting point of 180° C. has an exceptional affinity for the metalloids; forms a nitride NLi_3 when cold and LiH in hot state, absorbs C, P, S, and gas inclusions from melts. Li bearing ores are described: lepidolite is used in glass making for reducing the viscosity of the melt. Li metal is cast in bars and stored in tightly soldered metal containers to exclude air and humidity; it is 98-99% pure and costs about 120-150 gold marks/kg. A few tenths % addition of Li to Al alloys increases their hardness, and up to 6% to Al alloys with Zn, Pb, Cu, Mg, increases tensile strength and hardness, accelerates aging and facilitates working. The German "Bahnmetal" composed of 98.56% Pb, 0.73% Ca, 0.58% Na and 0.04% Li is used for bearing bushings in railroad motors. Alloys of 75-35% Be and 25-65% Li are extremely light, 1.0-1.5 sp. gr., and are at present still in state of investigation. Li compounds are also used in photography and medicine.

Ha (11a)

Committee on Aluminum Conductivity Standards, Communications of the Deutsche Gesellschaft für Metallkunde (Ausschuss für Aluminiumleitungsnormen, Mitteilungen der Deutschen Gesellschaft für Metallkunde). WIESTHALER. *Zeitschrift für Metallkunde*, Vol. 26, Aug. 1934, page 191. By reducing the Si content of commercially pure Al wire stock an increase in the electrical conductivity to 34.8 $\frac{m}{ohm \cdot mm^2}$ at 20°C. and an improvement in the corrosion resistance and dynamic strength have been attained. The tensile strength was simultaneously reduced to 25,500 lbs./in.² in wires of 0.118" diameter.

FNR (11a)

11b. Ferrous

E. S. DAVENPORT, SECTION EDITOR

Structure and Mechanical Properties of Large Forgings (Gefüge und Festigkeitseigenschaften grosser Schmiedestücke). E. MAURER & H. GUMMERT. *Stahl und Eisen*, Vol. 54, Dec. 13, 1934, pages 1281-1289; Dec. 20, 1934, pages 1309-1320. 45-ton ingots of a 0.35% C steel; a 0.38% C, 1.25% Mn steel; a 0.28% C, 2.0% Ni steel; and a 0.37% C, 2.96% Ni, 1.15% Cr, 0.42% Mo steel were forged and the mechanical properties compared with previous results on 100-ton ingots (*Stahl und Eisen*, Vol. 53, 1933, pages 209-215, 243-251, 271-281). The tests were made after 2, 3, and 5-fold reduction by forging, in the forged, normalized, and oil-quenched and tempered conditions. The forgings were 1020, 840, and 650 mm. in diam. The properties obtained are shown graphically. The alloying elements had slight effect on the character of the segregation which occurred in the ingots. Fine checks or cracks in the segregated zones were observed, these decreasing with the degree of forging; annealing after forging and furnace cooling tended to eliminate them. Forging improved elongation, reduction of area, and impact resistance. The relation between transverse and longitudinal properties improved with the degree of forging; in the Cr-Ni-Mo steel it was most favorable after 5-fold reduction; in the other steels after smaller reductions. The degree of reduction had little effect on grain size. Normalizing, and to a greater extent oil quenching, resulted in grain refinement and improved properties. Comparisons with the results on 100-ton ingots indicated that the mechanical properties are but little affected by the original ingot size. However, the grain size was finer in the 45-ton than in the 100-ton ingots.

SE (11b)

Hardening and Tempering of Steels Containing Carbides of Low Solubility, Especially Vanadium Steels. E. HOUDREMONT, H. BENNEK & H. SCHRADER. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication*, No. 585, Dec. 1934, 29 pages. Data are given on the influence of quenching and tempering on the properties of V steels. These show that for V steels and other steels containing special carbides hardening power is low when quenched from the usual quenching temperatures because of the insolubility of the special carbides at the quenching temperature. As the quenching temperature is raised hardening power increases. High quenching temperatures do not produce large grains in steels containing special carbides because the carbides retard grain growth. On tempering, special carbides separate at high temperatures, above 500° C., and increase hardness because of precipitation-hardening effect. The red hardness of high-speed steel can be attributed to precipitation hardening induced by separation of carbides. 13 references. See also *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 437.

JLG (11b)

Manganese in Straight Carbon Steels of Hardening Quality. GLYN POWIS. *Heat Treating & Forging*, Vol. 20, Nov. 1934, pages 544-545, 552. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 35.

MS (11b)

Factors Determining the Impact Resistance of Hardened Carbon Steel. HOWARD SCOTT. *Transactions American Society for Metals*, Vol. 22, Dec. 1934, pages 1142-1173. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention 1934. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 36.

WLC (11b)

The Influence of Vanadium on Carbon Steels and on Steel Containing Nickel and Chromium. H. H. ABRAM. *Iron & Coal Trades Review*, Vol. 129, Sept. 28, 1934, page 471. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 582.

Ha (11b)

Manufacture and Properties of Malleable Cast Iron (Fabrication et Propriétés des Fontes malléables). L. GUILLET. *Usine*, Vol. 43, Oct. 4, 1934, page 37. See "Present State of Malleable Cast Iron Manufacture," *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 582.

Ha (11b)

Steels for Die-Casting Dies. SAM TOUR. *Heat Treating & Forging*, Vol. 20, Oct. 1934, pages 491-494, 496. Paper read before the American Institute of Mining & Metallurgical Engineers. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 582.

MS (11b)

Effect of Various Alloys in Steel. N. L. DEUBLE. *Blast Furnace & Steel Plant*, Vol. 22, Aug. 1934, pages 439-444. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 536.

MS (11b)

Hydrogen Embrittlement of Steel (Ueber die Wasserstoffbrüchigkeit des Stahles). PETER BARDENHEUER & HEINRICH PLOUM. *Die Naturwissenschaften*, Vol. 22, Sept. 22, 1934, pages 656-657. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 536.

EF (11b)

General Relation Between Grain-Size and Hardenability and the Normality of Steels. E. S. DAVENPORT & E. C. BAIN. *Transactions American Society for Metals*, Vol. 22, Dec. 1934, pages 879-925. 9 references. Paper read and discussed before the Grain-Size Symposium, A.S.M. Convention, 1934 and previously abstracted from Preprint 14, 1934, see *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 536.

WLC (11b)

Effect of McQuaid-Ehn Grain-Size on Hardness and Toughness of Automotive Steels. H. W. MCQUAID. *Transactions American Society for Metals*, Vol. 22, Dec. 1934, pages 1017-1037. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention, 1934, see *Metals & Alloys*, Vol. 5, Nov. 1934, page MA 536.

WLC (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Physical and Structural Problems in Boiler Construction (Physikalische und bauliche Probleme im Dampfkesselbau). OTTO SCHÖNE. *Die Wärme*, Vol. 57, Nov. 24, 1934, pages 797-826. Adoption of the creep limit according to Siebel-Ulrich is urged, viz. 1×10^{-4}%/hour after a permanent elongation of 0.2% of the gage length. Tabulated data are given on structural materials incorporated in 5 German boiler plants recently built. Diagrams compare the creep resistance of various steels according to the definition of Siebel-Ulrich and Pomp-Enders, respectively. The favorable effect of Mo on the creep resistance is emphasized. Cr-Mo steels require 2 heat treatments, namely an annealing at 900° C. followed by an anneal at 700° C. Ni and Ni-Cr steels did not meet the strength requirements at elevated temperatures. 151 references. EF (12)

Utilization of Steels in Boiler Plants (Zur Verwendung von Stählen in Kesselanlagen). ERICH LACHMEIER. *Die Metallbörse*, Vol. 24, June 9, 1934, pages 728-729; June 16, 1934, pages 762-763. Creep is considered to be a secondary cause of disintegration of austenitic steel, grain growth at elevated temperatures, equilibrium changes and formation of carbides, scaling and diffusion processes, decarburization and other structural changes. The creep testing equipment developed at the Kaiser Wilhelm Institut für Eisenforschung is considered at length and the experiments of Pomp & Enders and Pomp & Höger are reviewed. Mo, Cr and Ni steels show a much higher creep resistance than plain C steels. The marked drop between 400° and 500° C. is reduced. Since amounts of 1% of those elements show a remarkable effect, these special steels are not too expensive for boiler material. Cu steels with only 0.24% Cu showed improved physical properties at elevated temperatures. Ni exhibits the least pronounced effect and Mo in combination with Cr yielded the best results. EF (12)

Structure and Creep Strength of Steel (Gefügeausbildung und Dauerstandfestigkeit von Stahl). E. H. KLEIN. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Dec. 29, 1934, page 1498. Creep strength is here defined as the admissible load of structural steels at temperatures up to 500° C. Investigations of other workers are briefly reviewed and the conclusion is drawn that the increase in size of particles and in coarseness of the grains increases creep strength. Ha (12)

Determination of Creep Strength of Aldrey and Pure Aluminum (Bestimmung der Dauerstandfestigkeit von Aldrey und Rein-Aluminium). IRMANN & W. MÜLLER. *Aluminium*, Vol. 17, Jan. 1935, pages 7-10. The abbreviated creep test methods proposed by Pomp and Höger for steel were applied to aldrey and pure Al. A comparison with a test extending over a year showed slightly higher values for the long time test. The admissible elongation velocities and testing times must be longer for these 2 materials (at least 25-35 hrs.) than for steels as the former harden less rapidly in the test than C steels. Ha (12)

The Tensility of Soft Steel as Affected by Temperature. H. D. HIBBARD. *Industrial Heating*, Vol. 2, Feb. 1935, pages 73-76. The tensile strength of low C steel from —80° to 1500° C. increases, according to numerous investigators, from a minimum at 100° to —100° and on the other side to 300° where a maximum is reached from which it rapidly decreases. Another minimum and maximum occurs at 800° and 900° C. resp. but much less pronounced. The C content is of little effect at elevated temperatures. A curve for 0.1% C steel shows average values for tensile strength; each part of C in 10,000 raises the tensile strength about 1000 lbs./in.^{2} which may be added to or subtracted from the values of the curve. Ha (12)

Change of Properties of Steel Wire by Storage at Room Temperature and by Cold (Ueber die Aenderungen der Eigenschaften von Stahldraht durch Lagerung bei Raumtemperatur und durch Kälte). KL. LIEBERKNECHT. *Mitteilungen aus dem Forschungs-Institut der Vereinigten Stahlwerke Aktiengesellschaft, Dortmund*, Vol. 4, June 1934, pages 83-112. The effect of storage, tempering and cold on wires of basic and acid steels, and the solubility in HCl of drawn wires of different composition and rate of reduction were investigated. Storing of longer duration at room temperature and tempering at 250° C. for 1 hr. increased tensile strength with increasing time of storage, but the increase was the smaller the greater the reduction in drawing; a dependence on C content and manner of manufacturing methods could not be observed. Elongation was generally reduced by storage, and more so in wires with slight reduction than with strong reduction; acid steel usually showed a better behavior after 1 than after 2 heat-treatments. Storage reduced the bending number somewhat; an influence of C content, reduction or manufacture could not be stated. Between 0° and —20° C. tensile strength and elongation increased generally with decreasing temperature; the reduction of area was not affected. The bending number was in most cases at 0° lower and at —20° higher than at room temperature; a difference between basic and acid steels could not be stated. Tempering caused practically always the same changes as storage. Increasing temperature increased solubility more or less according to composition; increased reduction had the same effect. Short annealing at 500° C. reduced solubility except for reduction above 90%. 18 references. Ha (12)

Fittings for Hydrogenation Plant. A. T. BARBER & A. H. TAYLOR. *Mechanical World & Engineering Record*, Vol. 97, Jan. 11, 1935, pages 37-38. Abstract of a paper "High Pressure Plant for Experimental Hydrogenation Processes," presented to the Institution of Mechanical Engineers. When bolts and nuts (made from mild steel and some alloy steels) and other threaded fittings have been subjected for several hours to a temperature of 850° F. or more, seizing has been experienced. Types of joints are discussed. Permanent joints are usually made by means of oxyacetylene welding but the deposited metal has to be free from slag inclusions and porosity. After steel parts have been in contact with H under pressure for a comparatively short time, it is difficult to make a weld, owing to the absorption of H in the metal. H can be driven out by heating the steel to 250°-350° F. Blistering of drawn tubing, used as pressure-resisting pockets for housing thermocouples, and causes of trouble are discussed. Kz (12)

Elastic Properties of Cast Aluminum Alloys. M. VON SCHWARZ & A. EVERS. *Foundry Trade Journal*, Vol. 50, Apr. 26, 1934, page 270. Abstract of translation from *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, page 37. See "Influence of Temperature upon the Elastic Properties of Aluminum," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 494. CEJ (12)

Qualifications of Steels for High Temperature Service. A. E. WHITE, C. L. CLARK & R. L. WILSON. *Steel*, Vol. 95, Nov. 26, 1934, pages 25-29. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 36. MS (12)

Development of Heat Resistant Alloys (Contribution au développement des alliages résistant à la chaleur). E. PIWOWARSKY. *Revue de Métallurgie*, Vol. 31, Oct. 1934, pages 452-459. Summary of the subject based on published data. JDG (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Application of a Few Statistical Principles to Corrosion Problems. GORDON N. SCOTT. *Oil & Gas Journal*, Vol. 33, Oct. 25, 1934, pages 74-80. There is a definite need in the industry for a method for quantitatively describing the condition of a pipe line. As a basis for such a system certain statistical principles appear well suited. The application of these principles has been illustrated by actual pit depth measurements taken from pipe lines. One of the characteristic features of soil corrosion data is the wide dispersion which is found in pit depth measurements. The distribution is very seldom normal. However the means of a smaller number of measurements do approach normality. By using Tchebycheff's theorem it is possible to predict from small samples (number of measurements) the number of lengths of pipe in a system falling outside certain values of pit depths. While the exact number of pipe lengths having pit depths greater than an assigned value cannot be predicted with accuracy, it can be definitely determined that the value of such lengths is not greater than a certain value. The author advocates that the industry should foster a quantitative view of corrosion and begin the collection of quantitative data. No length of coated or uncoated pipe should be exposed or removed from the ground from now on without a quantitative description (maximum pit depth) of its condition being recorded. The manner of collecting such records should be uniform and described in detail so that records from different sources would be comparable. Such records would cause little or no additional expense and if confidentially or openly reported to a central agency would create information of inestimable value. VVK (13)

The Use of Bureau of Standards Soil Corrosion Data in the Design and Protection of Pipe Lines. K. H. LOGAN. *Proceedings American Society for Testing Materials*. Vol. 34, Pt. II. 1934, pages 138-152, discussion pages 153-155. In 1922 the National Bureau of Standards undertook to determine whether serious corrosion could occur underground in the absence of stray electric currents. The existence of such corrosion is demonstrated by the data, but the solution of the problem of economically reducing the corrosion is incomplete. Soils rather than materials control the corrosion of existing pipe lines. The Bureau of Standards data on the corrosiveness of soils must be modified by coefficients or factors which take account of conditions not represented in the Bureau tests. Further work is required to determine the significance of certain tendencies shown by the data; notably, the effects of the size and age of the specimen on which pit measurements are made, the protective effects of corrosion products and the results of departure from homogeneity of the soil with respect to its physical characteristics. An economic solution of the problem of protecting pipes against corrosion cannot be found until numerical values can be assigned for the life of unprotected pipes and the life extension to be expected as the result of the use of a protective coating. Ideas as to the necessary qualities of a satisfactory coating have been developed but there are no satisfactory ways of measuring these qualities or of determining the amounts of each property which are necessary. This paper is a comprehensive review of the Bureau of Standards work on corrosion and protection of pipe lines with the above as a general summary of conclusions. VVK (13)

The Action of Water on Lead with Special Reference to the Supply of Drinking Water. Summary of Existing Knowledge. H. INGLESON. *Water Pollution Research Technical Paper No. 4, Department of Scientific and Industrial Research, London,* 1934, 115 pages. 2s. 0d. A review of 371 references covering Pb content of drinking water, plumbism and protective measures adopted, action of water on Pb, electrolytic action of Pb, effects of dissolved substances on Pb, etc. Authorities differ as to the safe Pb content of drinking water, some considering 0.3 to 0.5 p.p.m. as the limit of safety, others that 0.1 should not be exceeded. When an outbreak of plumbism occurs a temporary expedient is the displacement of stagnant water in the pipes before using any for drinking purposes and the use of some form of filter to remove Pb. In certain cases replacement of Pb service pipes by Fe or Cu is practicable. Modifying the water at the works by increasing the carbonate hardness or the silica content or decreasing acidity by addition of alkali or removal of CO_2 have been found valuable. Excessive quantities of dissolved O should be prevented. The behavior of distilled water containing dissolved O and CO_2 towards Pb seems to depend on the relative concentrations of these gases. It is generally agreed that calcium bicarbonate can protect Pb under certain conditions. The action of water on Pb has been associated with physical and chemical heterogeneity but little is known of the effects of metallic impurities. Previous mechanical treatment has a marked effect. Acid waters obtained from moorland sources have given considerable trouble on account of their plumbosolvent action. VVK (13)

Special Zinc for the Manufacture of Batteries (Spezialzink für Elementefabrikation). A. BURKHARDT & G. SACHS. *Metallwirtschaft,* Vol. 13, Nov. 16, 1934, pages 809-813. Zn sheets for the manufacture of dry cells, made by a new melting and pouring process, have greater and much more uniform corrosion resistance, regardless of the origin of the Zn. This process prevents the bath temperature from rising to more than 10°C. above the m.p. and usually holds it within 2° or 3° of the m.p. The corrosion resistance is determined by the Kohen test, in which the rise in temperature on immersion in 18% H_2SO_4 is measured. In every case Zn cast at low temperature had a good and that cast at high temperature had a poor Kohen test. The Kohen test had no relation to the Fe or Cd content, and no difference in X-ray structure was found. Zn of any one brand cast at low temperature was softer than that cast at high temperature, but the hardness and strength of different brands is affected by their composition as well as casting temperature. A definite relation was found between casting temperature and micro-structure. Low casting temperature produces Zn with the impurities finely divided and uniformly distributed, while high casting temperature causes the impurities to segregate at the grain boundaries. This is visible even in unetched polished specimens. 7 references. CEM (13)

Beating Air Preheater Corrosion at Tecumseh Power Station. F. A. RUMATZ & D. K. JOHNSON. *Electric Light & Power,* Vol. 12, Aug. 1934, pages 13-15. S in fuel is greatest contributor to corrosion with the H_2 content next in importance. The deposit of corrosive acid solution on preheater plates is dependent upon the dew point of vapors. The greater the H_2 in fuel the larger the amount of H_2O and higher dew point of gases. The temperature of the plates was increased to above the dew point to prevent precipitation. Ferrubron, a metallic paint used for recirculator, reduced corrosion losses. WB + MS (13)

Corrosion in the Chemical Industries. VI. O. A. KNIGHT. *Mineral Industries, Pennsylvania State College,* Vol. 3, May 1934, page 4. General. AHE (13)

Electrolysis and Corrosion Damage Warehouse. DON HULL MCCREERY. *Civil Engineering,* Vol. 4, Nov. 1934, pages 572-575. Serious structural damage to the reinforcing steel in a concrete warehouse used for hide-curing was observed after 2 years. This is ascribed to electrolytic action set up by impurities in the steel in the presence of brine which seeped through the concrete. HCl was generated and in some cases nearly destroyed the steel without altering the appearance of the surface of the concrete. JCC (13)

Paints for Ship Bottoms (Skeppsbottomfärger). CURT MARCUS. *Teknisk Tidskrift,* Vol. 64, Nov. 10, 1934 (Section *Kemi*) pages 84-87. Best protection from rust is afforded by paints made from iron oxides, barite, zinc oxide, and zinc or lead chromates. Lead oxide is not recommended for use on ship bottoms. Good protection against living organisms is obtained with copper paints and other metallic paints. BHS (13)

Graphitized Cast Iron. Interesting Case of Decomposition of Pipe Line. J. N. C. MACTAGGART. *Commonwealth Engineer,* Vol. 22, Sept. 1, 1934, page 53. Paper before the Institution of Civil Engineers, Sydney, Aug. 1934, describes the deterioration of low-level sewage pipes laid in 1907. The completely graphitized tubes do not show the least difference between the skin and the center and the samples that are in an intermediary stage of decomposition are also of the same appearance from one side to the other. Pipes embedded in concrete did not exhibit this defect indicating the effect of external influences. Large amounts of ferric oxide leached into the surrounding earth were noticed. WH (13)

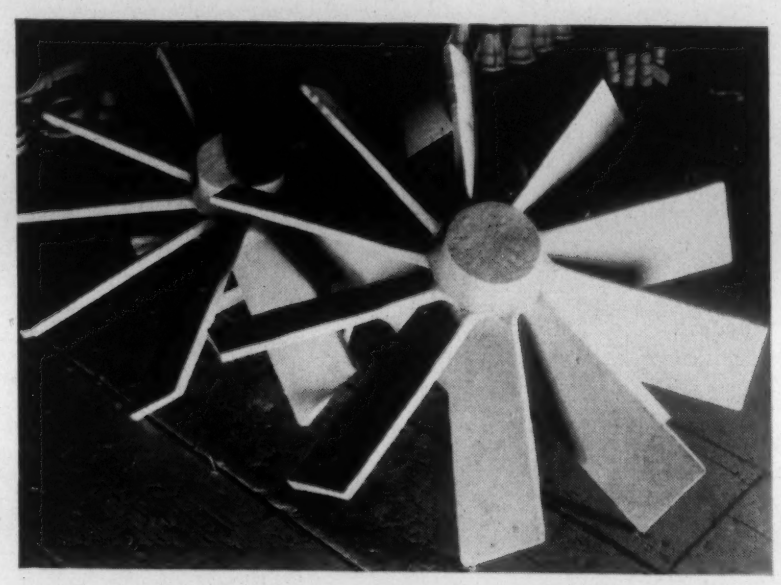
Use of Light Metals in Salt Works (Wie steht es mit der Verwendung von Leichtmetallen in Salinenbetrieben?). ERWIN SIEGMUND. *Kali, verwandte Salze und Erdöl,* Vol. 28, June 15, 1934, pages 148-150. See *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 319. EF (13)

Study on the Passivity of Iron and Steel in Nitric Acid Solution. Report IV. YOICHI YAMAMOTO. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 23, Dec. 1934, pages 1501-1507. In Japanese. *Abstracts of the Bulletin Institute of Physical & Chemical Research,* Tokyo, Vol. 13, Dec. 1934, pages 85-86. In English. The ability of HNO_3 to convert Fe and steel into the passive state was found to be increased by additions of Na nitrite. This effect is ascribed to the formation of nitrous acid due to the presence of Na nitrite the action of which is diametrically opposite to the influence of urea. The passivity of Fe brought about instantaneously in HNO_3 was not destroyed by adding Na nitrite a few minutes after the Fe had become passive. WH (13)

Increase of Dissolving Velocity of Iron by Oxidizing and Reducing Substances (Die Erhöhung der Auflösungsgeschwindigkeit des Eisens durch oxydierende und reduzierende Substanzen). F. TOEDT. *Angewandte Chemie,* Vol. 47, July 7, 1934, page 508. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 588. Ha (13)

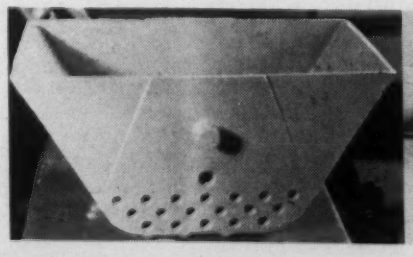
CORROSION RESISTING ALLOYS

DURIMET
DURCO KA2S-KA2S Mo
ALCUMITE



Low carbon KA2SMo AGITATORS 3' in diameter with 5" blades for stirring corrosive solution in large chemical plant.

RASCHIG RING SUPPORTS in *low carbon* DURIMET, 37" diameter, cored holes in center, 1" drilled holes in rim, total weight 230 lbs.



Low carbon DURIMET PICKLING BASKET for use with 20% Sulphuric Acid.

ALCUMITE SOLDERING JIG, one of five, very resistant to soldering flux.

The buyers of these castings are convinced that equipment which will stand up under severe conditions is a good investment.

You probably are just as much interested in reducing costs, saving money, time and labor. Why not write and find out if any of these alloys will apply in your case? No obligation, of course. Just write THE DURIRON COMPANY, Inc., 432 N. Findlay St., Dayton, Ohio.

ALLOYS for CORROSION RESISTANCE

14. APPLICATION OF METALS AND ALLOYS

Apparatus of the Inorganic-Chemical Heavy Industry (Apparaturen der anorganisch-chemischen Grossindustrie). B. WAESER. *Werkstoffe & Korrosion*, Vol. 9, Dec. 10, 1934, pages 45-47. Steels and cast irons produced in Germany particularly for use in the inorganic chemical industry, to withstand chemical attack and corrosion are reviewed and patents described. Cr-Ni and Cr-Al-Fe alloys, with or without additions of Zr, Be, Ti or Ta are favored, also Monel metal and other Ni-Cu alloys. Alloys of Pt or Pd with Au or Ag are used for the very fine nozzles and orifices for artificial silk manufacture because of their hardness and corrosion resistance. In the field of refractories, a new line has been developed containing SiC in addition to Al_2O_3; it is called "Carsial":

	SiC	density	compression strength	softening point under 2 kg./cm.² load, °C.
	%		kg./cm.²	
Carsial I	90	2.40	>1000	>1750
Carsial II	80	2.35	>1000	>1750
Carsial III	70	2.30	>1000	1660
Carsial IV	60	2.25	1000	1550
Carsial V	50	2.20	800	1450

Heat-insulating materials are made of the oxides of Al, Mg, Be, Zr and Th and can be used for temperatures from 1900° to 2500° C. Ha (14)

The Weather—It Takes Steel to Do Something About It. T. H. GERKEN. *Iron Age*, Vol. 135, Jan. 3, 1935, pages 101-102, 105-107. Approximately 25,000 tons of rolled steel were used during 1934 in the manufacture of air conditioning equipment and related products. The industry also used 10,000 tons of steel castings, 5,000,000 lb. of Cu and a large amount of Al. Because of comparatively high price, volume demand for complete units does not seem likely in the near future. At least 2,500 railroad coaches and Pullman cars were air-conditioned during 1934. Many hotels, restaurants, office buildings and theaters have also been air conditioned during the past year. In all systems a moderate amount of steel is needed in the form of fans, pipe and tubing. Gives a table, taken from Bureau of Census, showing orders for air conditioning equipment, 1931-Sept. 1934. VSP (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Aluminum Alloys for Engines. G. D. WELTY & F. C. PYNE. *Aviation*, Vol. 33, Sept. 1934, pages 286-288. Physical properties of the following Al sand casting and forging alloys at room temperatures are tabulated:

Casting	Cu	Fe	Si	Zn	Mg	Mn	Ni	Al (Minimum)
	12.0	..	...	...	...	..	...	85.5
	7.5	1.2	...	1.75	...	..	...	87.5
	10.0	1.2	...	...	.25	..	...	87.0
	4.0	..	...	...	1.5	..	2.0	90.0
	1.2	..	5.0	...	.5	..	...	92.0
	1.4	..	5.0	...	.5	.75	.75	89.5
	4.5	..	...	...	...	..	...	93.0
Forging	4.0	..	...	...	.5	.5	...	92.0
	4.0	..	...	...	.5	...	2.0	91.0
	4.5	..	0.8	...	...	.8	...	92.0
	0.8	..	12.0	...	1.0	..	.8	82.0
	...	..	1.0	...	.6	..	...	96.5

The use of these alloys in power plants for crankcases, link rods, super-chargers, nose pieces, bearing caps, generator and starter parts, impellers, etc., is discussed and illustrated. Further tables present data on mechanical properties of some of the above listed alloys after exposure to 400° and 600° F. for approximately 75 days and on specific gravity, electrical conductivity and coefficient of expansion. EF (14a)

Economic Use of Electroplated Domestic Materials (Devisenersparniss durch Verwendung veredelter heimischer Werkstoffe). *Metallwaren Industrie & Galvano Technik*, Vol. 32, July 15, 1934, pages 307-310. Discusses from economical viewpoint the substitution of Cu and Cu alloys by electro-plated Fe and steel objects. Considers galvanizing, Cd plating, Pb wiping, Ni and Cu plating, and non-metallic coatings whereby special attention is paid to the danger of corrosion. The use of Al in place of Cu and its alloys is discussed and electroplating and oxidation of Al is dealt with. EF (14a)

Aluminum Alloys Up to Date. C. F. NAGEL & F. C. PYNE. *Aviation*, Vol. 33, July 1934, pages 212-214. Information is given on mechanical properties (sheets, tubes, extruded shapes) and heat treatment of Al alloys recently developed by the Aluminum Company of America. No analyses are included. Corrosion tests on Alclad under laboratory and service conditions are reported. No loss of physical properties of the 0.0095" Alclad skin of the metal-clad airship ZMC-2 was noted after 4 years of service. EF (14a)

Navy and Marine Memorial Is Cast of Aluminum. T. D. STAY. *Foundry*, Vol. 62, Dec. 1934, pages 12-16, 52. Describes the use of Al in casting the Navy and Marine Memorial and the method of procedure. VSP (14a)

Craft Built of Light Alloy. *Journal of Commerce (Shipbuilding & Engineering Edition)*, Nov. 29, 1934, page 5. Description of a 65 ft. cruiser powered by two 160 B.H.P. engines constructed throughout of the Al-Mg alloy known as "Birmabright." The main plating of the hull, deck and bulkhead plating, frames and sections, and the rivets were all of this alloy, as were also such parts as davits, sidescuttles, compass equipment, and deck and cabin fittings supplied in the form of castings. JWD (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

A Portable Steel Road. *Engineer*, Vol. 158, Nov. 30, 1934, page 547. Major H. S. Briggs has invented and patented a new type of steel construction to be used for temporary roads in time of war. Pressed steel channels are used which are made so that the flange of one interlocks with the flange of the next one. These channels are laid transversely to the length of the road. They can be laid by unskilled workmen in any kind of weather and the softer the road-bed, the more support is given to the channels. LFM (14b)

Sheet Steel Telegraph and Transmission Poles. *Engineering*, Vol. 138, Nov. 23, 1934, page 561. Brief illustrated article describing poles manufactured under a patent held by E. C. Kny of London and K. Brehme of Hollister, California. Patina steel is used which has a high resistance to corrosion and a tensile strength of 38 to 44.4 tons/in.² The sheets are made into cylinders which are welded together. For storage and transportation purposes the sections can be telescoped into one another forming a nest which can easily be handled by one man. LFM (14b)

Perforated 18-8 Steel Sheets Form Planetarium Screen. *Steel*, Vol. 95, Aug. 27, 1934, pages 28-29. Dome for the Fels planetarium in the Franklin Institute, Philadelphia was covered on the inside with stainless steel sheets, hung from structural members and joined by shotwelding. Sheets about 1/32 in. thick and perforated with 4300 1/16-in. holes per sq. ft. permit 97% of the sound to pass through and be absorbed by acoustical material on the walls behind. Spraying inner surface of steel with light-reflecting paint provided reflectivity. MS (14b)

How Traffic Signs Are Cut, Painted, Mounted and Maintained. *Steel*, Vol. 95, Aug. 13, 1934, pages 28, 31, 44. Describes practice of the city of Cleveland, O., with regard to traffic signs, sign-posts, safety zones, and traffic poles. Signs are of 14-gage galvanized steel sheets. In some manufacturing districts, signs must be replaced every 3 months. Cr-plated signs did not last any longer than ordinary signs. MS (14b)

Railroad Coach Construction Lowers Operating Costs. *Steel*, Vol. 95, Oct. 8, 1934, pages 33-34, 39. New passenger coaches of Chicago, Milwaukee, St. Paul & Pacific Railroad are of all-arc-welded steel construction and weigh 35% less than conventional coaches of the same size. They are moderately stream-lined and tubular in shape, with a roof of turtle-back form. Describes construction and assembly. MS (14b)

Circular Telephone Booth of Sheet Steel Has Utility and Improved Appearance. *Steel*, Vol. 95, Nov. 15, 1934, page 43. Describes booth developed by Sherron Metallic Corp., Brooklyn. It is of spot-welded construction. MS (14b)

H-Piling Finds Use in Piers, Bridges and Fish Traps. *Steel*, Vol. 95, Nov. 12, 1934, pages 33-34. Gives examples of the use of H-type structural steel-piles far varied types of construction on the Pacific coast. While particularly adapted to hard driving, they are satisfactory in soft ground also, and have surprising bearing capacity. MS (14b)

Welded Steel Frame Used in New 12-Room Residence. *Steel*, Vol. 95, Nov. 26, 1934, pages 40-41. Describes house being built in Toledo, O., and method of fabrication and erection. Arc welded construction is used throughout. MS (14b)

Sewage Disposal Plant Uses Much Stainless-Clad Pipe. *Steel*, Vol. 95, Aug. 20, 1934, page 33. Stainless-clad steel plates are being formed and arc welded into 1800 ft. of pipe, 2-5 ft. in diam., for the Milwaukee sewage disposal plant. MS (14b)

Porcelain Enameled Steel Buildings. LE ROY W. ALLISON & MALCOLM B. CATLIN. *Iron Age*, Vol. 134, Sept. 6, 1934, pages 18-23. Discusses the architectural aspects, development and trends of application of porcelain enameled steel to building construction. VSP (14b)

The Place of the Enameled Steel House. LE ROY W. ALLISON & MALCOLM B. CATLIN. *Iron Age*, Vol. 134, Sept. 13, 1934, pages 14-19. Traces the progress and prospects of porcelain enameled steel buildings. Extensive research and experiments on the part of sheet steel manufacturers and enameling interests, with cooperation of architects, are responsible for the present status of steel dwellings. Results to date show sound accomplishments in architectural innovation. VSP (14b)

Using Sheets for Road Foundations. N. L. ANDERSON. *Steel*, Vol. 95, Sept. 17, 1934, pages 40-41. Paper read before the International Congress for Steel Development, June 20-23, 1934. MS (14b)

Iron and Steel of Better Qualities. ROBERT S. ARCHER. *Metal Progress*, Vol. 27, Jan. 1935, pages 22-26, 64. Discusses improvements in casting irons by improved knowledge of known alloys and additions of other elements. Better sheet steel, more knowledge of hardening, grain-size control, high alloy steels and possibilities of structural uses of stainless steels are discussed. WLC (14b)

Large Uses of Steel in Small Ways. No. 267. Vibrating Screens. *Steel*, Vol. 95, Aug. 13, 1934, page 38.[4] In a normal year about 1000 tons of steel and a similar tonnage of castings are used in the industry. MS (14b)

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15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

15a. Economic

Some Experiments in Making Rails According to OST-418 Specifications. P. A. KOUDRYAVTZEV. *Domez*, No. 10, 1934, pages 22-37. (In Russian). The quality of the rails supplied to Russian railroads has steadily dropped during recent years. Rails are not removed from the track when worn, but only when broken. In 1931, 59,797 such rails were removed from the trackage of the whole Russia and 40,894 during the first 6 months of 1932. Almost 80% of the removed rails were fractured in service. New specifications were introduced to remedy this trouble: 0.38-0.50% C, 0.60-1.00 Mn, 0.08 max. P, 0.06 max. S; 70 kg./mm.² tensile strength and 60 mm. max. bend after the first impact of the tup. Old specifications were met by 82.8% of all rail production in Russia in 1931, by 71.4% in 1932 and 59.5% in the first quarter of 1933. Tears were responsible for 50% of scrap, scabs for 11%, physical properties for 17%. One rail plant made 63 heats in a Bessemer converter to check the feasibility of these specifications. Only 27.6 of all heats were within chemical specifications. Rolling 12 satisfactory heats into rails yielded 18.6% of rails which passed the above specifications, though 73.4 of them passed the old specifications. Detailed records are given. (15a)

International Cooperation of the Aluminum-Producing Countries in Scientific, Technical and Economical Questions (Die internationale Zusammenarbeit der Aluminiumerzeugenden Länder in wissenschaftlichen, technischen und wirtschaftlichen Fragen). *Aluminium*, Vol. 17, Sept. 1934, pages 61-64. A report of the "Intalbo", Dept., Germany, describes the present status of the international organization, the members and organizations participating in different countries, the fields which have already been organized, and their functions. Ha (15a)

The Iron and Steel Institute in Belgium and Luxemburg. *Engineer*, Vol. 158, Sept. 21, 1934, pages 280-281. Brief description of various plants visited by members of the Institute during their foreign tour in Sept. 1934. LFM (15a)

World's Output of Chrome Ore. *Iron & Coal Trades Review*, Vol. 129, Dec. 14, 1934, page 929. Output of Cr producing ores in principal countries for 1932 and 1933 is given; the total was 230,000 and 273,000 (long) tons resp. Ha (15a)

World's Output of Pig Iron and Ferro-Alloys. *Iron & Coal Trades Review*, Vol. 129, Dec. 21, 1934, page 983. Statistics according to countries are given for 1932 and 1933; the total was 38.9 and 48.4 million tons resp. Ha (15a)

World's Output of Iron Ore. *Iron & Coal Trades Review*, Vol. 129, Dec. 21, 1934, page 979. Statistics according to countries are given for 1932 and 1933. The world's total amounts to 75 and 80 million tons resp. Ha (15a)

15b. Historical

With Hammer and Torch (Med Hammare och Fackla). Fifth Yearbook issued by SANCTE OERJENS GILLE. Ivar Haeggströms Boktryckeri A. B., Stockholm, 1934. Paper, 6¾ x 9¾ inches, 155 pages.

A historic review containing much interesting data on the development of the Swedish iron and steel industry. Of particular interest is the address by Arvid Johansson given at the 75th anniversary of the introduction of the Bessemer process in Sweden. The first successful blow was made on July 18, 1858, at Edske blast furnace; without the pioneering work done at this plant the introduction of the process in England and on the European continent would unquestionably have been delayed for many years. B. H. Strom (15b) -B-

Electric Furnace in Sweden (Le four électrique en Suède). R. PITAVAL. *Journal du Four Electrique*, Vol. 43, Nov. 1934, pages 387-389. Historical sketch. JDG (15b)

High Test Cast Iron in Competition (Hochwertiges Gusseisen im Wettbewerb). JOH. MEHRTENS. *Zeitschrift für die gesamte Giesscreipraxis*, Vol. 55, Nov. 11, 1934, pages 465-466. Abstract of author's paper before meeting of foundry foremen, Sept. 15, 1934, Berlin, giving historic survey of methods for processing high test cast Fe. GN (15b)

History of Iron in India. H. CECIL JONES. *Iron & Coal Trades Review*, Vol. 129, Dec. 7, 1934, page 893. The time of first introduction or production of Fe in India is not known but the art of melting and working Fe was known in Asia long before it reached Europe. A history of development up to modern times is given and some industrial plants named. Ha (15b)

Quarter Century of Alloy Steels—Significant Trends in 1933. EDWIN F. CONE. *Steel*, Vol. 95, Aug. 27, 1934, pages 25-27. Presents an analysis of the official statistics from 1909-1933 and a review of progress during the period in the United States. Tabulates total steel, total alloy steel, electric alloy steel, total alloy castings, and electric alloy castings production. During depression, percentage of alloy steel output of total steel production decreased during first 2 years and then increased; electric steel melting expanded in use; percentage of alloy castings of total alloy steel increased during first 2 years and then decreased; and percentage of electric alloy castings of total electric alloy steel increased in first year and then decreased. MS (15b)

The Works of the Sheepbridge Coal and Iron Company, Limited. P. A. FOX-ALLIN. *Foundry Trade Journal*, Vol. 50, Feb. 8, 1934, pages 103-106. Deals with the plant of the above company. OWE (15b)

News and Personals

Large Use of Steel by the Air Conditioning Industry

More than 600,000 tons of steel have gone into air-conditioning equipment, now in use in this country, and large future consumption of steel for this purpose is in prospect, according to the American Iron and Steel Institute. In thousands of theatres, stores, offices, railroad cars, homes and industrial establishments, air-conditioning equipment, largely made of steel, is creating ideal weather conditions 365 days a year, and the air-conditioning industry is expanding in many directions.

Sheet steel, copper-bearing, painted or galvanized, for building the ducts of central station installations and for the cabinets of unit types, is used in largest quantities. The tonnage of pipe and light shapes is increasing, however, due to recent developments in design. Steel in many other forms is also used in refrigerating apparatus.

Installations of air-conditioning equipment in 1934 is estimated to have required approximately 28,000 tons of steel, in various forms, and the market is expected approximately to double in 1935. Within the next ten years, it is estimated that 450,000 tons of steel a year will be used to build new "weather-controlling" machines.

Predicts New Automobile Engine Design

"Increasing engine speeds as well as the growing demand for power and smoothness with silence will eventually eliminate the present type of poppet valve engine, at least for passenger car work," states Joseph A. Anglada, prominent consulting automotive engineer and past chairman of the Metropolitan section of the Society of Automotive Engineers. Mr. Anglada's prediction was made on the completion of a tour through leading automobile engine manufacturing establishments, where he had an opportunity to examine research work conducted by these plants. According to him, automotive engineers are seeking to replace reciprocating with rotary motion wherever it is possible to do so. This is becoming increasingly important as engine speeds go up.

The **Timken Roller Bearing Co.**, Canton, Ohio, states it has received the largest single order for steel mill bearings ever placed in any country in the world. This is in connection with the new Zaporojstal steel mill recently ordered for the U.S.S.R. by the Amtorg Trading Corp. from the United Engineering & Foundry Co. It is estimated that approximately 1500 Timken bearings, weighing approximately 200 tons, will be used in this Russian mill.

Appointment of **Atlas Supply Co., Inc.**, 35-39 Woodward Ave., Brooklyn, N. Y., as warehouse distributors of rust-resisting Toncan iron sheets has been announced by N. J. Clarke, vice president in charge of sales, Republic Steel Corp., Youngstown, Ohio. A complete stock of sheets will be maintained.

Formation of the **National Copper Paint Co.**, an Illinois corporation, to manufacture and market the newly evolved liquid paint of 98.3 per cent purity, is announced by C. L. Welch, executive vice-president. Headquarters are at 666 Lake Shore Drive, Chicago. President of the company is H. M. Rice, manager of the Nichols Copper Company, Chicago, a unit of the Phelps-Dodge Corporation. Frederick A. McLauchlan, president of George B. Carpenter & Co., Chicago, is secretary and treasurer.

Thomas R. Langan, well known in the transportation world because of his important engineering and commercial activities in the fields of railroad and railway electrification, has been appointed traffic manager of the Westinghouse Electric & Mfg. Co., with headquarters in the East Pittsburgh Works.

Group Meetings of A.S.M. Chapters

A Tri-Chapter meeting of the Dayton, Columbus and Cincinnati chapters of the American Society for Metals will be held in Dayton, April 15. A symposium on the use of Controlled Atmosphere will be the feature of the afternoon program. Three speakers are scheduled: H. M. Webber, General Electric Co., "In the Joining of Metals"; S. K. Oliver, Delco Products Div. of General Motors, "In the Hardening of Tools" and R. J. Cowan, Surface Combustion Co., "In Production Heat Treating." Dr. Anson Hayes, director of research, American Rolling Mill Co., will be the after-dinner speaker in the evening on "Recent Metallurgical Developments." Dr. Krivobok will repeat his Campbell Memorial Lecture as the evening address.

A group meeting of four eastern chapters of the American Society for metals is being arranged for May 24 in New York City. The four chapters are the New York, the New Jersey, the Philadelphia and the Lehigh Valley, with the New York chapter acting as host. A fine technical and entertainment program is promised.

Metal Exposition in Japan

The Metal Industries Exhibition will take place in the Boekikan, the commercial house, in Osaka, Japan, May 10 to 31, 1935, under the joint auspices of AGNE and the *Nikkan Kogyo Shinbun-sha* (The Daily Industrial News). The exhibition is the largest usually held in Japan.

Economical Repair Job by Arc Welding

A spoked gear wheel, 7 ft. in diameter and weighing approximately 2500 lb., that had been badly broken and almost pulverized in parts, was repaired by arc welding at a cost of $80. A new gear would have required the outlay of several hundred dollars. The repair work was done by the Menna Welding Co., Toledo, Ohio, using a General Electric single-operator welding generator and G-E electrodes. One new spoke and a new section of the rim, representing about 7 teeth of the gear, had to be cast and welded into position to replace parts which had been too badly shattered to be reassembled.

The **Laclede-Christy Clay Products Co.**, with main office and plants in St. Louis, announces the removal of its Chicago district sales office at 766 Peoples Gas Building to its new headquarters and warehouse at 4452 West 5th Ave., Chicago. H. R. Hiller, long associated with the company in a managerial capacity both in St. Louis and Chicago, will remain as district manager.

The **Carnegie Institute of Technology** announces that there will be available for the coming academic year two teaching assistantships and one fellowship in the graduate department of metallurgy. These may be held by candidates for advanced degrees. Candidates should communicate immediately, addressing their communications to Prof. O. T. Geckeler, secretary of the committee on graduate instruction, Carnegie Institute of Technology, Pittsburgh, Pa.

W. A. Hauck has been appointed assistant to the president of Lukens Steel Co., Coatesville, Pa. He was formerly assistant comptroller of Bethlehem Steel Corp. Prior to joining Lukens, he was with tthe American Iron and Steel Institute, engaged in work in connection with the Code of the iron and steel industry.

Effective March 1, 1935, the business of **William H. Barr, Inc.**, was acquired and operated by the McCallum-Hatch Bronze Co., Inc. The business continues without interruption in service or inconvenience to any of its customers.

News and Personals

Additions to Battelle's Staff

Battelle Memorial Institute of Scientific and Industrial Research, Columbus, Ohio, announces the appointment of C. T. Greenidge to its technical staff. Prior to coming to Columbus, Mr. Greenidge was a research metallurgist with the A. O. Smith Corp. in Milwaukee. He has been assigned to work in connection with a new industrial project in the metallurgy of steel established at the Institute.

Carlos M. Heath has been appointed assistant metallurgist on the staff of the Battelle Institute. He is a graduate of Michigan State College from which institution he also received his master's degree. Prior to joining the Battelle staff, Mr. Heath held a position in the metallurgical department of the American Brass Co., at Waterbury, Conn. At the Battelle laboratories, Mr. Heath has been assigned work in connection with a new metallurgical project in the non-ferrous field.

Dr. Bruce A. Rogers has been added to the technical staff. After being graduated from Iowa State, he secured his master's degree at the University of Chicago, later receiving his doctor's degree in metallurgy at Harvard University. Dr. Rogers comes to Battelle from the Bureau of Standards where he was in charge of a survey of the engineering uses of silver, a research program sponsored by a group of silver producers. He is well known for his activities in the field of magnetic age-hardening iron alloys and for his work in high temperature microscopy. He was for several years connected with the metallurgical division of the Western Electric Co., Inc., in Chicago in charge of their metallographic work. At the Battelle laboratories he will be senior metallurgist on a new program of research work relating to the automotive industry.

The appointment of Myron R. Nestor, a University of Minnesota graduate, and Philip C. Rosenthal, a graduate of the University of Wisconsin, as members of the technical staff of Battelle is announced. Both of these men are metallurgists and have been assigned to a new industrial research project recently started at the institute.

To more conveniently serve its customers, in the South Central States, the **C. J. Tagliabue Mfg. Co.**, of Brooklyn, N. Y., has opened a new branch factory at 1916 Jackson St., Dallas, Texas. This branch takes the place of their old Shreveport, La. address which has been closed. The prime function of this new branch factory will be repair work, with special attention to emergency orders. In addition, however, adequate stocks of all "TAG" standardized instruments will be maintained. A. G. Koenig, southwestern district manager for the Tagliabue Co., will be in charge at Dallas.

The **Claud S. Gordon Co.**, 314 Indiana Terminal Warehouse Bldg., Indianapolis, Ind., has been appointed district representative of the Hevi Duty Electric Co., Milwaukee, Wis. **S. A. Silbermann,** who has been acting as subagent for several years for the Hevi Duty Electric Co., will be in charge of the Indianapolis office. **L. A. Shea** has been appointed as district manager for the State of Illinois and the upper half of the State of Indiana. His office will be at 205 West Wacker Drive, Chicago, Ill.

The **R-S Products Corp.**, Philadelphia, Pa., announces that the Claud S. Gordon Co., with headquarters at 708 W. Madison St., Chicago, and branch offices in Cleveland and Indianapolis, has been appointed representatives of all Ryan products in the territories indicated. The John R. Gearhart Co., with headquarters at 600 Fallon St., Oakland, Cal., has been appointed representative in the San Francisco territory. The R-S Products Corp., which took over the organization and the control of all products of Ryan, Scully & Co., two years ago, has considerably increased its line of standard furnace products and incidental items such as gas and oil burners, control equipment, etc., through additions to machine shop and plant facilities. All equipments are now manufactured under direct factory supervision.

John M. Mulholand, formerly special representative of railroad sales of the Youngstown Sheet & Tube Co., has recently been appointed manager of railroad sales for the company. Mr. Mulholand's headquarters will continue to be in Chicago.

Cooperative Research Program in Ferrous Metallurgy Inaugurated

The department of metallurgy of Pennsylvania State College, State College, Pa., announces a research program on carbon and alloy steels which has already attracted the cooperation and financial support of seven steel companies: the Allegheny Steel Co., Carpenter Steel Co., the Heppenstall Co., Latrobe Electric Co., Vanadium Alloy Steel Co., Bethlehem Steel Corp., and Republic Steel Corp. Each of these companies has contributed equally to the research fund, and has prepared certain material and test specimens used in the investigation.

In pursuing the research program close technical contact is being maintained with representatives of these companies in order to insure that the investigations undertaken shall have a definite practical aspect. The program which has been outlined so far includes investigations on the effects of stress and corrosion on alloys at elevated temperatures, and factors affecting the decarburization of steel. The project was started on September 1 under the direction of Dr. Charles R. Austin. Installment of the high temperature deformation apparatus has been completed and some interesting test data have already been obtained. The deformation equipment was especially designed for work of this kind and has been loaned to the School by the Westinghouse Electric & Mfg. Co. A recording potentiometer has been loaned by the Pittsburgh Experiment Station, U. S. Bureau of Mines.

This is the first cooperative research project in Metallurgy that has been undertaken at the College and it is expected that it will prove an aid in raising the standards and value of resident and extension work in this branch of the mineral industries.

Erle G. Hill has joined the **Lukens Steel Co.**, Coatesville, Pa., as director of research. He was graduated from the University of California. In 1920, he became an associate professor of metallurgy at the University of Pittsburgh, serving there for ten years. He resigned in 1930 to accept a research fellowship at the Mellon Institute of Industrial Research, remaining in that work until he joined Lukens company. He is a member of the American Institute of Mining and Metallurgical Engineers, American Society for Metals, American Society for Testing Materials and the Franklin Institute.

"The Revolution in Steelmaking" is the title of an address to be delivered by **Harry W. McQuaid,** of the metallurgical staff of Republic Steel Corp., before the Duluth Engineers' Club, Duluth, Minn., on April 15. Mr. McQuaid will point out the increased importance of raw material quality in the making of steels in this new era when the steelmaker has shouldered so much of the responsibility for the fabrication and service results of steel products. Mr. McQuaid is well known in metallurgical circles, having been the co-originator of the McQuaid-Ehn grain size test, now in universal use.

The **Copper & Brass Research Association** announces the removal of its office as of April 1, 1935, from 25 Broadway to 420 Lexington Ave., New York.

Karl M. Herstein, announces the opening of a new office in the Chemists' Building, 50 East 41st St., New York. He will continue his practice as consulting chemist, specializing in chemical technology and patents.

Gustav Thurnauer, president of the Aurora Metal Co., Aurora, Ill., has announced the election of **A. W. Lauder,** as vice president and general manager. Mr. Lauder was formerly president of the Trindl Corp., and prior to that was connected with Lyon Metal Products for many years.

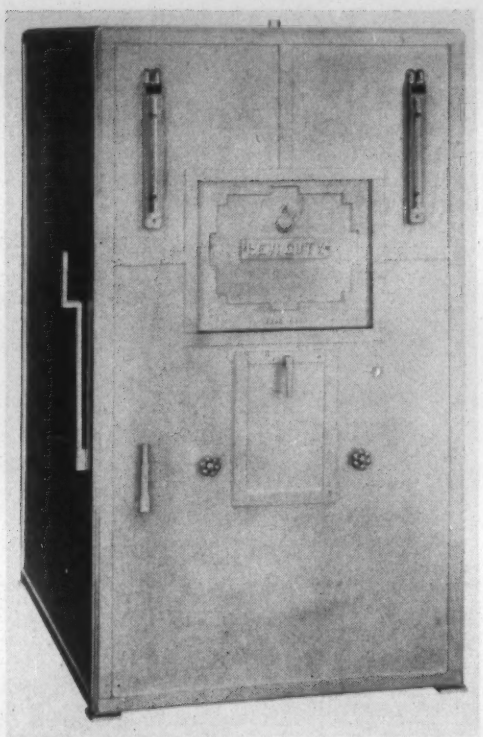
Arthur J. Tuscany, Cleveland, for the last seven years connected with the national organization in the gray iron foundry industry, has resigned as executive secretary of the Gray Iron Founders' Society, Inc., Cleveland, and has established headquarters at 1213 West Third St., Cleveland, to provide active and advisory service to trade associations and code authorities. At a recent meeting of its directors, Mr. Tuscany was named executive secretary of the Foundry Equipment Manufacturers' Association and of the Code Authority of the Foundry Equipment Industry.

NEW EQUIPMENT & MATERIALS

Furnaces Operating at 2300 deg. F.

The development of a new metallic resistor element by an American company has made it possible for the Hevi Duty Electric Co., Milwaukee, Wis., to announce a new contribution to the metal working and ceramic field. This is the development of a line of high temperature furnaces operating up to 2300 deg. F. in which this new element is incorporated. It can be operated, it is claimed, in either oxidizing or reducing atmospheres.

Since the inception of metallic resistor type of electric furnaces, the re-



sistor alloys in the nickel-chromium series has been used. These alloys have been limited to furnace applications in which temperatures did not exceed 2000 deg. F. For many years Hevi Duty tried to find a metallic resistor which could be used for temperatures in excess of 2000 deg. F., but with no great success. Until recently, the silicon carbide type of resistor has been the only one available for higher temperatures than 2000 deg. F.

Some years ago a research program was set up to develop a resistor alloy which would withstand higher temperatures than 2000 deg. F. As a result, a new resistor wire adaptable for this work was produced which, when used in connection with Hevi Duty's standard form of radiant plate construction, makes possible furnace chamber temperatures as high as 2300 deg. F. With Hevi Duty's radiant plate and tee support construction, full support is given the various strands of wire and a free release of heat is assured. Many breakdown tests with furnaces in actual operation indicate an element life at 2300 deg. F. comparable to normal expectancy of nickel-chromium operating at 1850 deg. F.

The new wire, it is claimed, has a resistance 45 per cent greater than nickel-chromium and a higher current carrying capacity which makes possible ample kilowatt capacity to handle the increased temperature requirements. No water cooling of the element terminals is required. The element can be readily welded. The furnace, as illustrated, is equipped with the Hayes "Gas Curtain" atmosphere control feature for providing either oxidizing or reducing atmospheres for the charge being treated. The protective atmosphere for the charge can be introduced direct into the furnace chamber without deteriorating the element.

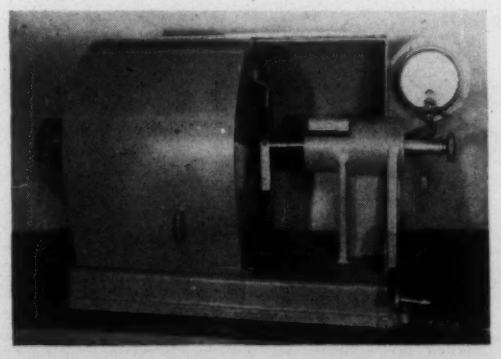
The installed capacity is 21 kw. for operation on 230 volts. The furnace will heat from room temperature to 2300 deg. F. in 1 hr. and 35 min., and has a radiation loss when saturated at 2300 deg. F. of 5.5 kwhr. per hr. After an overnight shut-down of 15 hr., the furnace drops to approximately 1000 deg. F. and will reheat to 2300 deg. F. in 55 min., says the company.

The heating element design is adaptable to many kinds of furnace types to suit various process requirements. Principally among these are the forging of steel, reheating billets, brazing, annealing of stainless steel, and ceramic firing. With this new type of resistor, it is believed that there is brought to industry a more uniform and accurate heating equipment which is most economical in operation.

A Torsion Impact Testing Machine of Large Capacity

The consulting staff of the Baldwin Southwark Corporation, Philadelphia, Pa., announces further facts regarding a development which is of more than ordinary interest to metallurgists and others who use heat-treated steels. The Carpenter Torsion Impact Testing Machine, announced some months ago, has been limited in the energy available for the breaking of the specimen to approximately 500 ft.-lb. This, in turn, limited the size of the specimen to ¼-in. diameter.

There has been a demand for a machine with greater stored energy in order that larger specimens might be broken by this new and novel method of impact testing. This demand for a larger machine to accept specimens more nearly equal in dimension to the service part is akin to that which, after the failure of the Quebec Bridge in 1907, prompted the building of several very large and powerful testing machines, of which the 2,300,000-lb. Emery Universal at the National Bureau of Standards is one.



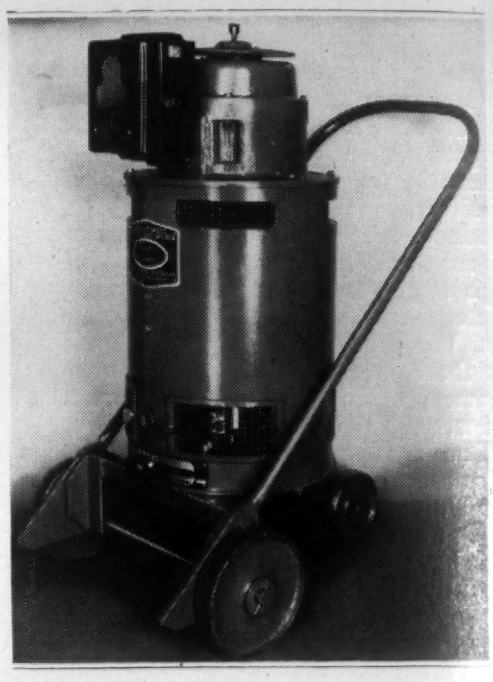
Therefore, in order to more nearly simulate service conditions, Baldwin Southwark organization has built for the Republic Steel Corp., a torsion impact testing machine, having a stored energy content of 100 times that of any such machine previously built. This new machine, illustrated herewith, has available at 1000 r.p.m., 50,000 ft.-lb. of energy—sufficient to test any known steel (under conditions usually obtained in such tests) in specimen diameters up to 1 in. and many steels up to 1¼ to 1⅜ in. in diameter.

The principles of this new machine are identical with those of the former 500 ft.-lb. machines heretofore described. A refinement, however, is the incorporation of a high grade Westinghouse Magneto type tachometer.

A 50-Amp. Vertical Welder

Answering the need for a low current arc welder capable of handling the lighter gauge metals used in auto bodies, etc., the Harnischfeger Corp., of Milwaukee, has announced a new P&H-Hansen 50-amp. vertical model.

The feature of this new welder, known as the W50-254, is the stable high speed arc which enables it to weld quickly and efficiently down to 26 gauge steels. No external reactors, resistors, or separate stabilizers are used; the self-stabilized arc is achieved through the use of an exclusive internal stabilizer winding. It



is claimed suited for welding of ferrous and non-ferrous metals in general repair work or for the fabrication of containers of stainless steel, phosphor bronze, aluminum, etc., with the metallic arc. It is of vertical or upright design, requiring less than 2 ft. of floor space. It is 15 in. wide and 36 in. high and supplied with base for stationary mounting or with wheels or lifting bail for easy handling around the shop.

Arc Welding Electrode Produces Self-Hardening Deposit

A new hard surfacing electrode, designed for building up straight carbon steel, low alloy or high manganese steel surfaces to resist abrasion, is announced by The Lincoln Electric Co., Cleveland, Ohio. Known as "Abrasoweld," it will be found of particular value in such applications as restoring teeth, lips and bottoms of power shovels, lugs and treads of tractors, and so on.

"Abrasoweld" electrode provides a deposit of abrasion resisting alloy of the self-hardening type which surface hardens very rapidly under conditions of impact and abrasion. This type of deposit is claimed to have definite advantages over that which shows its maximum hardness as deposited. The tendency of the deposit to chip off in service is eliminated. Added to these advantages the "Abrasoweld" deposit is said to be more resistant to corrosion than high manganese steel.

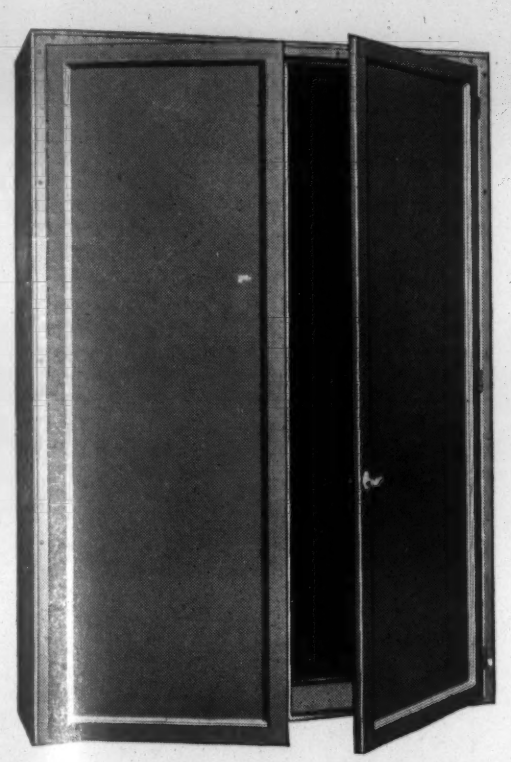
"Abrasoweld" electrode is made in $\frac{5}{32}$ in. size, 14 in. in length. It is used with reversed polarity with a current range of 125-200 amp. and 24 to 27 arc volts.

Cabinet Type Steel Meter Panel

A cabinet type steel meter panel equipped with doors to protect and conceal meter and control connections is now being offered by Bailey Meter Co., Cleveland, Ohio.

A panel of this type with flush mounted equipment presents a pleasing appearance not only from the front, but from the rear as well. The neatly paneled doors are provided with a 3-point locking mechanism and a substantial cylinder lock which may be used to prevent unauthorized persons from gaining access to electrical connections, control mechanisms and meter adjustments located within the cabinet.

These panels are thoroughly durable, being made of one piece sheet steel plate formed in proper sizes to give



symmetrical and uniform appearance regardless of the quantity or type of meters and instruments to be installed on the board.

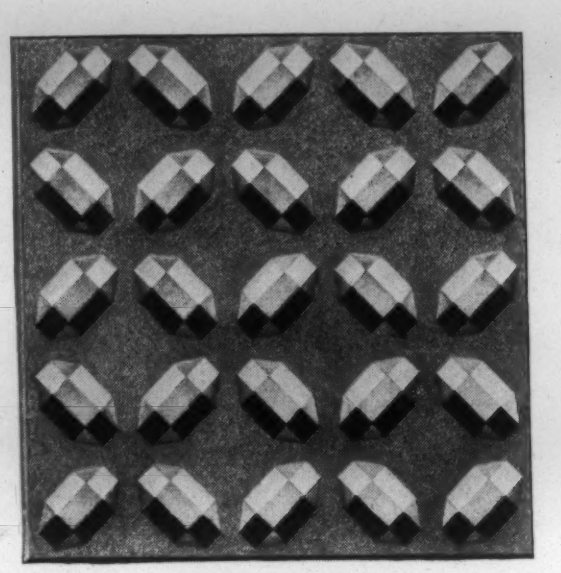
Self-supporting construction, which greatly facilitates installation, is secured by bending the sides of the panel back to form supporting wings. Although the completed panel is self-supporting, a base flange drilled at convenient intervals provides means for securely bolting or lagging it in place. This base flange which is entirely concealed within the cabinet is formed by bending both the front and wings inward through an angle of 90 deg. The entire panel is finished in a smooth and luxurious black tone which gives all the appearance of slate or composition with the durability of steel.

A New Mining Cable

A new cable with loom-woven sheath, for use on mining machines, reel locomotives, and other applications of a similar nature where the cable must withstand severe mechanical abrasion, is now available from The General Electric Co. The finish of this cable consists of a circular-loom-woven sheath, applied in a manner similar to the weaving of a carpet. Under this sheath is a layer of Glyptal cement, the sheath being so applied that it is embedded in the Glyptal cement and partially embedded in the rubber insulation. This process results in a cable that is tough, extremely abrasion resisting, and because of the Glyptal cement, highly resistant to oil, alkali, and acid.

"Multigrip"—A New Floor Plate

Multigrip, a new floor plate, has recently been announced by Illinois Steel Co. The design of the plate has been developed by long experimentation to assure the highest degree of skid resistance from every angle. Other features of the



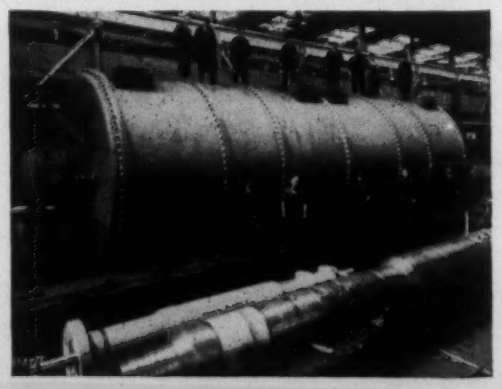
One-Half Actual Size

new plate are its comfort under foot, for while it offers a sure tread there are no sharp protruberances. All lugs have a flattened top surface. Multigrip may be cleaned readily and drains freely. There are no pockets in which water can accumulate. Its symmetrical design minimizes waste in cutting. It is available in standard weights and sizes.

First Hydrogen-Cooled Frequency Changer

The first frequency changer in which are incorporated the advantages of operation in an atmosphere of hydrogen has been completed at the Schenectady works of the General Electric Co. and will be installed at the Freemansburg, Pa., substation of the Pennsylvania Power & Light Corp.

The new frequency changer will convert 60-cycle, 3-phase power to 25-cycle, 3-phase power for use at the Bethlehem Steel Co.'s plant at Bethlehem, Pa. The motor of the new set is a 24-pole, 12,000-volt, 300-r.p.m. machine rated at 23,500 kv-a at 0.9 power factor. The generator has 10 poles, and at 6,900 volts, 0.9 power factor, will deliver 22,222 kv-a.

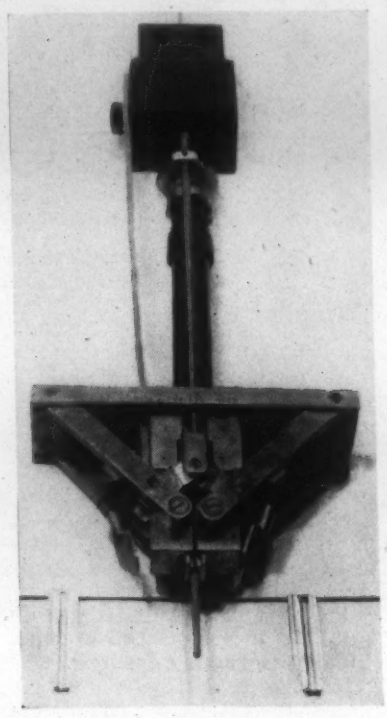


The use of hydrogen cooling in this new frequency changer is an outgrowth of the development of hydrogen-cooled synchronous condensers by General Electric during the last few years. Hydrogen is a more efficient cooling agent than air, permitting a saving in size for the same power rating. With hydrogen, the windage loss is about 10 per cent of that with air—this loss being nearly proportional to the density of the gas in which the machine operates. Electrically, the tendency for the formation of corona is eliminated by the use of hydrogen.

Automatic Arc Welding With Heavily Coated Electrodes

The use of Woven Welding Wire and Electrode Contactor apparatus, as covered by patents and letters patent applied for, manufactured by The Welding Wire Co., 28 Harvard St., New Britain, Conn., allows full automatic metallic arc welding with heavily coated electrodes, to a point that requires mere push button start and stop control by the welding operator.

The electrode contactor apparatus used with woven welding wire consists of a toggeling, free passage contactor, that allows freedom in passage for foreign matter as well as separates the mechanical control, from the contactor, so as to have the control non-conductive from



current and heat standpoint, giving long life to the mechanical members. Tangential grip feed rolls are used on the electrode feed. A single adjustment, plunger roll type of straightener is included so as to eliminate the frictional wear on the contactor inserts which are made of cadmium-copper and have long life for this duty.

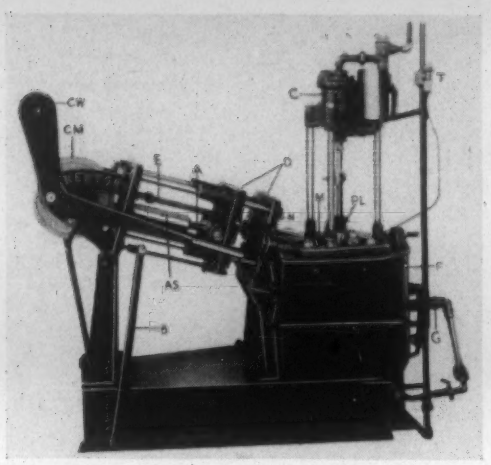
Welds made with woven welding wire and electrode contactor apparatus are claimed to have a tensile strength of 75,000 to 80,000 lbs. per sq. in. and show an elongation of 25 to 30 per cent in 1 in. Woven welding wire is furnished in coils having a tapered bore so as to be readily placed on the reel for use, the average coil change being less than one minute. Straightened and cut lengths of woven welding wire are available for manual operation, packed in 15-lb. boxes.

New Type Centrifugal Pump

The American Hard Rubber Company, 11 Mercer St., New York City, offers its new type W. A. M. pump in the belief that it is the finest in the non-metallic field for medium capacities up to 90 gals. per min. at 12 ft. head. Every feature of the design has been worked out carefully on the basis that ability to handle acids and corrosive chemicals without difficulty is the first requisite. The casing of this pump is made of acid-resisting hard rubber and is claimed to be heat and distortion resisting. It is mounted to the base by means of an acid-resisting, hard rubber covered casting which acts as a chamber to catch drip from the stuffing box. By-pass is adjustable and cored right into the back casing. The motor shaft is especially extended, tapered and pinned into the pump shaft with all parts interchangeable.

Improved Die Casting Machine

The Newton-New Haven Co., New Haven, Conn., has recently introduced its latest type pressure casting machine known as the No. 500 four bar machine. This is a heavy duty plunger type machine for the pressure casting of zinc and zinc base alloys. A number of new features have been incorporated: Added ca-



pacity, quick die mounting, increased speed of production with ease of operation and added safety.

With the four bar type there is greater die capacity than on the former machines. Of the four sliding bars one is now removable to facilitate quick mounting of dies with automatic core pulls. Roller bearings have been included in the cam itself and in both cam shaft bearings. A fifth bumper bar has been added at the bottom of the sliding bolster to facilitate ejection in overhanging dies. Safety device has been incorporated to prevent operator making short or pump until die is locked tight. The machine is equipped with automatic temperature control of metal insuring proper casting temperature at all times.

High Duty Draw-Cut Flash Trimming Machine

A high duty, draw-cut, flash trimming machine, built by the Morton Mfg. Co., Muskegon Heights, Mich., is especially built for trimming the flash from butt welded sheets having a seam up to 120 in. in length. It is designed to trim stock as thin as 20 gauge.

The machine follows in design this company's patented feature of vertical moving ram-carrying member which raises the upper ram and clamping the dies 2 in. vertically for ease in entering and removing the work. The upper ram is raised and lowered by roller bearing eccentrics. Hardened steel lined dies are secured to the ram housing member and the rams and cutting tools travel in the path parallel with the hardened die surfaces. The upper ram is provided with

automatic compensation to take care of variation in metal thickness. This permits the trimming of a 20 or 16 gauge metal without any change in tool setup.

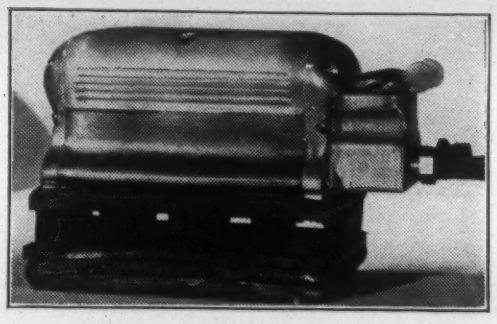
Power is applied to the two reciprocating rams by means of direct connected reversing type motor. A series of cutting tools, each securely fixed in the ram by patented adjustable tool holders, are used. A unique feature is the die cleaning and centering method.

Sanding Machine Cuts Time Element in Half

A unique sanding and polishing machine for industrial use is being introduced by the Sterling Products Co., Detroit and Los Angeles. It weighs 7 lbs., and operates on 60 lbs. or more of compressed air (using 6 cu. ft. of air per min.), thus making it suitable for small shops as well as the heaviest production lines.

The Sterling Speed-Bloc Sander is unique in that its sanding motion is an oscillating or reciprocating one. The stroke travel of the abrasive pad is 1¼ in., at the rate of between 2500 and 3000 oscillations per minute. The pad moves back and forth with the same motion as in hand sanding, thus leaving no graining or chasing in the surface.

The sanding pad is driven directly from the motor, sealed in an aluminum case. It is made of specially impreg-



nated rubber and felt. Several sheets of abrasive may be attached to the pad at one loading.

Due to its light weight and small size (7 in. long, 7¾ in. high, and 3¾ in wide), the Sterling Speed-Bloc Sander can be used on all types of work for long periods of time without tiring the operator. It is claimed adaptable to work in any industry where abrasive paper, felt, or wool are used in finishing metal, wood, or composition surfaces.

Ball Bearing Buffers

The Baldor Electric Co. announces the development of a line of ball bearing buffers, both bench and pedestal type, in sizes ranging from 1/3 to

5 h. p. The features of this new line are: Large ball bearings, totally enclosed, extended end bells, long distance between wheel centers, heavy shaft, and free of vibration.

For more complete information and prices, write to the Baldor Electric Co., 4357 Duncan Ave., St. Louis, Mo.

A Heat-Treating Furnace Recently Improved

The Philadelphia Drying Machinery Co., 3356 Stokley Street, Philadelphia, Pa., announces a furnace recently improved, which is suitable for the carburizing, tempering, annealing and heat treating of ferrous and non-ferrous metals. It also is suitable for batch treatment of porcelain, glass, or other ceramics. Temperature ranges vary from 600 to 3300 deg. F.

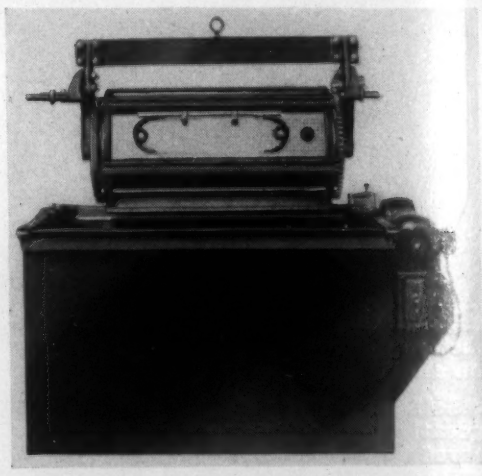
Gas-firing equipment is supplied with either the high or low pressure combustion systems. Oil firing equipment makes use of the company's low pressure oil burner.

On both the gas and oil-fired units, the equipment is said to assure maintenance of correct atmosphere in the furnace chamber. Where the work requires partial or total exclusion of the products of combustion, the furnace can be supplied with semi-muffled or completely muffled chambers.

The Udylite Plating Barrel

The Udylite Co., Detroit, Mich., has just developed a plating barrel which is said to be outstanding because of its strength, durability and efficiency.

It is constructed of the strongest possible combination of materials—steel and shock-resistant rubber. The cylinder consists of a framework of steel into which are fitted rubber rails and heads. The entire steel framework is anodically charged so that it does not plate. Rubber was chosen as the insulating material for the panels, rails and heads, because



it does not disintegrate by absorbing plating solution as do bakelite and woods; because it will resist wear better than any material available for plating barrel construction.

The durability and efficiency are dependent on the insulation. Proper, efficient insulation eliminates treeing which is the principal cause of barrel destruction and loss of efficiency. In the Udylite barrel, there is no treeing! All of the current goes directly to the work.

Mechanical features include: Heavy panels of special shock-resistant rubber made to Udylite specification; rubber rails, steel reinforced, accurately slotted for perfect fit with panels; heavy rubber cylinder heads; steel end plates reinforce rubber heads of cylinder; cylinder does not rotate on dangler arbor, completely eliminating treeing at the usual slip joint construction, and soon.

A New "Purifier" for Iron and Steel

"Iron Regenerator" is the name given to a preparation in powder form for the purification of iron and steel. It is claimed to combine simplicity in application, excellence in its effects and economy in use with immediate reation. It is offered by Foundry Serv-

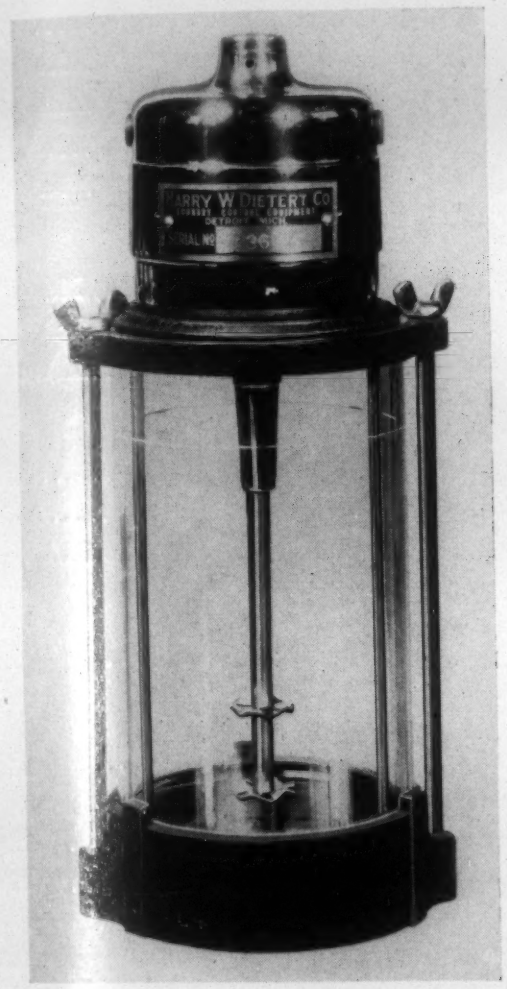
ices, Inc., 107 East 41st Street, New York, N. Y.

Its main advantages are claimed to be: Removing of iron oxide, removal of slag inclusions, a closer grain, easy skimming, easier machining properties, no attack on linings or crucibles and no fumes. The expense in its use is said to be negligible.

A Rapid Sand Washer

A rapid sand washer, a new development, is announced by the Harry W. Dietert Co., Detroit, Mich. It is used in foundry sand testing laboratories to scrub the clay bond free from the sand grains of a moulding sand.

After the sand is treated for 5 min. in the washer, the motor is lifted from the wash bottle and the suspended



clay bond is syphoned off, leaving the sand grains in the bottom cup of the wash bottle. This cup is placed in an oven to dry the sand grains, after which they are weighed.

The percentage of clay is calculated by the difference of weight before treating and after the washing operation. Overall height of unit is 12 in. and it weighs 10 lb. The motor is 110 volt, 1/30 h. p.

Straight Cutting Oils

A new series of straight cutting oils, combining refrigeration and high film strength, has been announced by E. F. Houghton & Co., 240 W. Somerset St., Philadelphia. As a result of extended experiments in its research laboratory, the conclusion is reached that the modern cutting oil must have a high degree of heat absorption properties and further must provide an enduring film of oil on the tool, thus substituting fluid friction for plastic friction, which in turn reduces the amount of heat generated. The company points out that cutting oil must be fluid so that it will penetrate quickly, back of the cutting edge of the tool, which progresses at high speed. It further maintains that this cutting oil must have a high film strength to withstand extreme pressures exerted on the tool. Because the cutting oil is used over and over again, it is imperative that the physical and chemical properties should remain the same over long periods of time. All of these qualities are built into the new series of straight cutting oils, now available including Super Refrigerant Base and Frapol No. 414 and No. 418. It is stated that these cutting oils will withstand full loads on standard Almen and Timken testing machines without failure, thus meeting the requirements of film strength because of the extreme pressure which has been given them. A new folder describing these oils in greater detail is available.

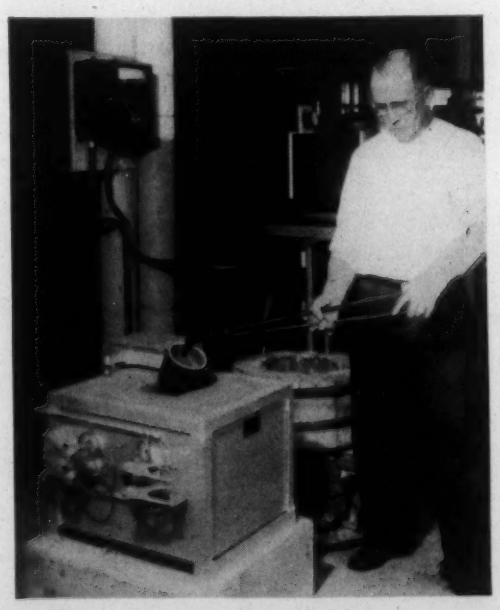
New Laminated Contact Button

The General Plate Co., manufacturers of thermostatic bimetal and other laminated metals, are now producing a new electrical contact button made of fine silver backed-up with steel. It is stated that these laminated buttons cost far less and actually wear longer than solid silver. They can be furnished with suitable projection areas on the back which facilitate spot welding the buttons to support members of steel, brass or copper and reduce assembly time and costs.

It is further stated that this type of button does not lose its shape even when contacts vibrate and pound together. They are made with flat or dome contact faces, in all sizes. Descriptive literature and samples may be obtained from the makers, the General Plate Co., 33A Forest Street, Attleboro, Mass.

Hayes Electric Melting Furnace

A laboratory or experimental melting furnace for temperatures up to 2500 deg. F. is announced by C. I. Hayes, Inc., 129 Baker St., Providence, R. I. It is designated the HM-10 type and is described as suitable for melting gold, white gold alloys, silver and



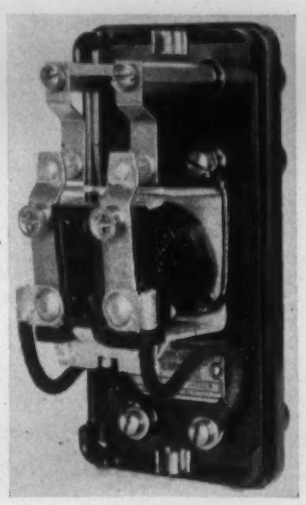
other metals within the maximum temperature range of 2500 deg. F. for which it is designed. It is also pointed to as ideal for testing refractory materials and for determining the fusing point of coal ash.

The heating chamber is 6 in. deep with top opening 5 in. by 5 in. sq. It is heated by Glober heating elements, and equipped with water-cooled terminals. It operates on a connected load of 8 kw., with 110 or 120 volts, a.c. or d.c.

The furnace is also supplied with atmosphere control for the prevention of oxidation.

New Low-Priced Auxiliary Relay

A small, sturdy, low-priced auxiliary relay for use on a.c. or d.c. and suitable for switchboard or panel mounting is announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The type SK auxiliary relay for switchboard mounting has a molded cover or molded cover with glass front; the front connected panel mounted relay uses no cover. Both types have two independent contact circuits which may be easily adjusted for circuit-closing or circuit-opening service. For two independent opening circuits, additional material must be added to the standard relay.



Designed for continuous duty at rated voltage, the SK relay is obtainable for circuits up to 550 volts a.c. or 440 d.c. Ranges up to 250 volts can be used for intermittent duty up to approximately three times their continuous value. The relay can be supplied with a coil for any current value up to 5 amp.

Relay is adapted for any thickness of panel material from ⅛ in. (steel) to 2 in. (slate). The molded terminals are 1-⅛ in. long, being ample for steel-panel mounting. For thicker panels, extension terminal studs are furnished.

Each contact will carry 12 amp. continuous and 20 amp. for one minute. The non-inductive rating:

Volts d.c.	Interrupting Rating, Amp. dc.	Interrupting Rating, Amp. a.c.
24	12	20
48	6	20
115	3	20
230	1.25	10
550	0.25	3

Liquid Copper Paint

M. H. Rice, metallurgist and manager of the Nichols Copper Co., Chicago, a unit of the Phelps Dodge Corp., has announced that a new chemical process has been discovered for reducing copper to a non-crystalline form, suitable for use in a liquid vehicle and giving in effect, the equivalent of a liquid copper. The metal, 98.3% pure, can now be applied in this liquid form, says Mr. Rice, to give a sheath of copper upon almost any surface. The new product is not to be confused with the common copper oxides or bronze powders, he points out. By virtue of the shapeless form of the tiny copper particles, which are so small that they penetrate a 350-mesh screen, no minute gaps are left in the coating after application by spraying, dipping, or by a brush. The copper remains in suspension in the special vehicle that has been developed, assuming an approach to a semi-colloidal state, it is reported.

Laboratory and field tests indicate that the product should have a useful life of five to ten years or longer. It is also claimed highly resistant to acid and other forms of corrosion. Discovery of the process is credited to two university scientists who worked for more than eight years in a private laboratory in Chicago.

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